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A NEW SITE FOR THE 20,000,000-gallon driven well plant for Camden, N. J., has been selected at a point much nearer the city than the original location. This will save 16,000 ft. of 36-in. cast-iron pipe, for which the contractor allows $105,000, making the price for the new supply $420,000. The new location is near the present reservoir in the town of Stockton, N. J., and the land comprises 56 acres of meadow ground, triangular in shape, with a frontage of about 1,000 ft. on the New Jersey channel of the Delaware River. Work will be started at once. The contractor, Mr. Geo. Pfeiffer, Jr., has sublet parts of the work as follows: Driven wells, Kisner & Bennett, Belmar, N. J.; two 10,000,000-gallon horizontal compound pumping engines, Holly Manufacturing Co., Lockport, N. Y.; stand-pipe, Tippett & Wood, Phillipsburg, N. J. It is expected that the driven wells will be about 90 ft. deep. A bond of $200,000, guaranteeing quantity and quality of supply for ten years, has been given by the contractor.

BIDS FOR LAKE TUNNELS AT CLEVELAND, O., are wanted until July 31, as stated in detail in our advertising columns. It is proposed to build a brick-lined tunnel 9 ft. in diameter and 26,000 ft. long, terminating four miles from the shore of Lake Erie. Bids are also desired for an 8¼-ft. brick-lined tunnel 15,000 ft. long, extending from the present intake crib. Mr. D. E. Wright is director of public works.

TESTS OF TWO 30,000,000-GALLON Holly triple expansion vertical pumping engines for the Philadelphia Water-Works were recently made by Prof. H. W. Spangler, M. Am. Soc. M. E., and Mr. D. A. Decrow, M. Am. Soc. M. E. From a report of the test sent us by Mr. John C. Trautwine, Jr., Assoc. Am. Soc. C. E., Chief of the Bureau of Water, it appears that the engines exceeded the duty guarantee of 120,000,000 ft.-lbs., one by 8.5 and the other by 4.5%.

A WATER FILTRATION COMMITTEE has been appointed at Pittsburg, Pa., by the mayor, Mr. Henry P. Ford. Among the eight members are Messrs. Robt. Pitcairn, Superintendent Pittsburg Division and General Agent of the Pennsylvania Railroad Co.; E. M. Bigelow, Director Public Works; and Dr. J. Guy McCandless. The advisability of filtering the present water supply from the Allegheny River will be considered.

SLOW SAND FILTRATION FOR INDIANAPOLIS has been formally adopted by the Indianapolis Water Co., and Mr. Allen Hazen, of Noyes & Hazen, Boston, has been invited to prepare the necessary plans for the construction of filter beds. This will be supplementary to the present supply from infiltration galleries, driven and deep drilled wells. Mr. T. A. Morris is president, and Mr. F. A. W. Davis is treasurer of the Indianapolis Water Co.

A CHEMICAL PRECIPITATION PLANT for treating the sewage of the Wayne County poor farm buildings, near Detroit, Mich., has just been completed. The engineer for the work was Mr. Geo. Y. Wisner, Sanitary Engineer for the Detroit Board of Health. The sewage first passes through a 30-ft. mixing channel, where it receives lime and alum. It then goes through three precipitating tanks placed side by side, each 4½ × 75 ft., giving a total flow of 225 ft. The effluent falls 4 ft. over a series of steps for aeration and finally discharges through an iron pipe into a small brook leading to the River Rouge. The plant cost about $10,000. Heretofore crude sewage has been discharged into the river, but complaints were made before the court, it is said, and the practice was ordered stopped.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred June 27, on The Union Pacific, Denver & Gulf Ry., near Bierstadt, Colo. An express train consisting of engine, baggage car and two coaches ran into an engine which was taking water. Both engines were wrecked, and one engineman was killed and several persons were injured. The express was 15 minutes late.

A NEW BRIDGE FELL under an electric car near Carrollton, O., July 1. The accident was caused by the derailment of the car, wrecking one of the trusses of the bridge. The line on which the accident occurred is owned by the Dayton Traction Co., and was opened for traffic on the day of the accident. Two cars containing invited guests were run over the line, and as one of these entered a bridge over a canal between Alexandersville and Carrollton, the front truck left the rails and struck the side of the bridge. The car was going very slowly and, according to the account in a Dayton newspaper, the bridge broke in two at the center and sank down so gradually that no panic was caused among the passengers, and the car remained right side up, but with one end tilted down to the break at the center of the span. No one on the car was injured. From a rough newspaper sketch, we judge the bridge was a pony truss structure of wooden or composite construction.

A WOODEN HIGHWAY BRIDGE COLLAPSED at Hancock, Md., June 29. A four-horse team with a load of bark was crossing it. One driver was killed and another seriously injured. The bridge was built in 1889. It had been considered dangerous, and props had been placed under it, running up from the bed of the creek.

THE TIDAL WAVE which followed the earthquake in Japan on June 18 is stated to have devastated the northern shores for 170 miles; many sea coast villages were totally destroyed and several thousand people are estimated to have lost their lives.

A LOCOMOTIVE BOILER EXPLODED, July 2, on the Louisville & Nashville Ry., 27 miles north of Birmingham, Ala. Three men were killed and 18 cars were wrecked. The engine is said to have been in good condition at the beginning of the trip.

A RIOT was precipitated at Cleveland, O., last week by a student from one of the scientific schools, who, in company with several others, had been conducting a series of tests at the works of the Brown Hoisting & Conveying Machine Co. Upon emerging from the works he was threatened by a crowd of strikers and shot one of them in self defense. In the fight that followed between the strikers and police a number of people were injured. The strike is occasioned by the workmen's objection to the employment of non-union men.

A PHOTOGRAPH OF A TORNADO has been sent us by Mr. K. E. Hilgard, M. Am. Soc. C. E., Engineer of Bridges, Northern Pacific R. R., in response to the statement made in our issue of June 11, that so far as we knew only two such photographs had ever been taken. This photograph was taken by Fredericks & Koester, of St. Paul, Minn., and shows the so-called Lake Gervais cyclone, which occurred July 13, 1890. Owing to the blackness of the sky and the faint outlines of the funnel-shaped cloud, the possibility of a successful engraving is doubtful, and we do not reproduce the photograph, but refer to it here as a matter of record in connection with the Oklahoma tornado illustrated in Engineering News of June 11.

THE PASSENGER DEPOT of the Baltimore & Ohio R. R. at Wheeling, W. Va., was carried away by a flood on July 6. The depot was built at the mouth of Wheeling Creek.

FATAL ACCIDENTS FROM ELECTRIC CARS in Brooklyn now number 156 since the first introduction of the trolley, according to the records of the daily newspapers. The 156th victim was killed on July 8, and on the same day two collisions occurred, one at a crossing and one a rear collision. In the latter, two persons were injured.

THE TRANSMISSION OF ELECTRIC POWER has made it possible to operate, profitably, the Virginius mines of the Caroline Mining Co. at Ouray, Colo. These are situated near the summit of Mount Sneffles, in a region of perpetual snow, some 12,700 ft. above the level of the sea, or 5,000 ft. above timber line. Access to the mines in winter is impossible and in summer extremely difficult. Before the introduction of electricity in 1891, fuel, delivered at the mines, cost $18 per ton. The electric power now used is derived from water which passes through a pipe line 4,000 ft. long to Pelton water wheels driving General Electric dynamos located at the foot of the mountain. The transmission line for the electric current passes first through dense timber, then over rocks and chasms and heavy snow drifts until it reaches the mine four miles away from the power house. The current is direct and the potential 800 volts. The amount of power now used is double that supplied by the superseded steam plant, and it is estimated that the saving pays, each year, the entire cost of the plant.

A MAIL TUBE is under consideration for carrying mail between the New York and Brooklyn post-offices. If built it will cross the bridge and be operated by electricity or pneumatic pressure. The bridge trustees ask a rental of $8,000 for the first two years and $6,000 a year thereafter. It is stated that the post-office department is willing to pay from $14,000 to $15,000 a year to a company that will transport the mail by tube. The plan would greatly expedite the interchange of letters between the two cities and it is to be hoped that it may be carried out.

MAIL COLLECTING AND SORTING WAGONS are reported as the latest proposed improvement in the United States Postal Service. These wagons would run in outlying districts and by having the mail sorted on them and placed in separate pouches according to destination much time could be saved that is now lost in sending mail to central stations, besides the saving in time of collection. Motor wagons are talked of for this service.

ACETYLENE GAS FOR CAR LIGHTING is reported as having been tried on the Eastern Railway of France. The acetylene was compressed in a tank similar to that used for the gas ordinarily used in lighting on the road in question. A special Manchester burner, with a very small slit, was used.

EXPERIMENTAL HOT WATER MOTORS are to be tried on the New York and Putnam Branch of the New York Central Railway, between New York and Yonkers, it is reported. The motor was invented by Mr. W. E. Prall.

A NEW STEEL PLANT is being built at North Birmingham, Ala., by the Jefferson Steel & Manufacturing Co. A 15-ton Hawkins furnace will be put in operation July 10, it is expected, and nine more of the same style and size as soon as they can be completed. Mr. F. W. Hawkins, the patentee of the furnace to be used, is superintending the construction of the plant.

A NEW OIL PIPE LINE TO TIDEWATER will be completed soon by the United States Pipe Line Co. The company has been delayed by an injunction against crossing under the tracks of the Pennsylvania and Delaware, Lackawanna & Western Railway companies' tracks in New Jersey.

A DISINFECTING SHIP is nearly completed at the port of New York and will be used by the health officers in charge of disinfecting and fumigating vessels arriving from infected foreign ports. By its use it is hoped to reduce the time required to disinfect a vessel to one hour. Arriving vessels will be met and passengers transferred to the quarantine ship. All their wearing apparel will be subjected to a steam bath at 230° F.; and the passengers themselves will be obliged to take antiseptic baths.

FIVE NEW PIERS, capable of accommodating the largest steamships afloat, will be built on the North River water front of New York city within a year by the Dock Department. The piers will be 100 ft. wide and 675 to 730 ft. long. Two of the piers have been applied for by the Cunard line and two by the White Star line.

PROPOSALS FOR ORDNANCE MATERIAL are called for by the Ordnance office of the War Department until Aug. 3. The material desired includes 18 sets of forgings for 10-in. and 12-in. guns, and one set for a 16-in. gun, which will be the largest caliber yet attempted in this country. Proposals for 30 disappearing gun carriages, for 60 sets of steel mortar forgings, for finishing and assembling them, and for spring return carriages for mounting them are also asked.

THE THREE 30-KNOT TORPEDO CRUISERS authorized at the last session of Congress promise to be the subject of more competition than was expected. Besides the Herreshoff Bros. the Columbian Iron Works, of Baltimore, has announced its intention to submit bids, and it is thought that the Cramps and one or two other firms will also submit figures.

A NEW SOLID FLOOR FOR HIGHWAY BRIDGES.

Solid floors are very desirable for highway bridges, but in many cases the increased cost has prevented the adoption of such a floor. To meet the objections as to cost, and at the same time to provide sufficient strength and durability in

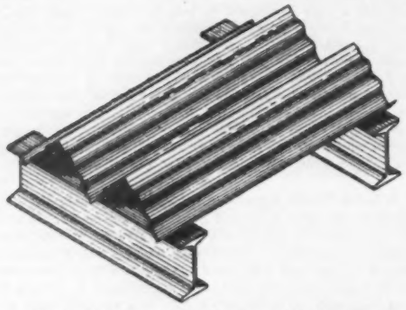


Fig. 1.—Galvanized Steel Troughs for Bridge Floor.

the cheaper floor, Mr. John O. Pew, General Manager of the Youngstown Iron & Steel Roofing Co., has designed and patented the system shown in the accompanying cuts.

It consists of a series of galvanized iron troughs, 5½ ins. deep and 9¾ ins. wide, each trough having one or more corrugations along its faces to stiffen it and bind the trough more firmly to the concrete filling. The general form of the trough is shown in Fig. 1. The metal varies from No. 20 to No. 10 gage in thickness; No. 20 is for bridge sidewalks, No. 18 for country bridge roadways, and No. 16 for city bridge roadways. The metal is galvanized to protect it from corrosion. In order to get sufficient bearing on the floor beams the lower edges of the trough rest in wrought-iron or cast-iron chairs on the beams. The concrete filling is made with Portland cement concrete, and is finished off to an even surface for the paving, the concrete being 3 ins. thick over the tops of the troughs, as shown in Fig. 2.

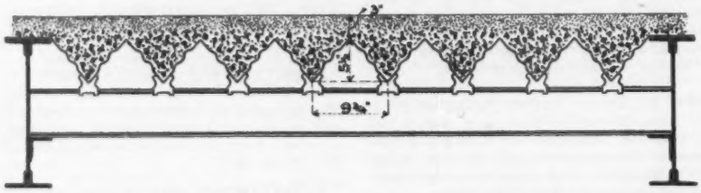


Fig. 2.—Cross Section of Solid Floor Roadway for City Bridges Showing Concrete Filling.

A section of floor having troughs of No. 18 steel, with a span of 3 ft. 10 ins., was loaded with pig iron, as shown in Fig. 3, the total load amounting to 16,534 lbs., or 1,016 lbs. per sq. ft. The load was not increased beyond this, as the pig iron could not be piled any higher. No appreciable deflection was noted, and the floor was in no way injured. This section of floor had concrete paving, 3 ins. above the tops of the troughs. Another test was made with a section of 7 ft. 10 ins. span, the troughs being of No. 16 galvanized steel, and the concrete being filled in to the tops of the troughs. This section carried without injury a load of 1,300 lbs. per sq. ft., the loading being then stopped on account of the height of the pile of pig iron.

The Youngstown Iron & Steel Roofing Co., of Youngstown, O., controls the patents, and we are informed that this floor has been adopted for heavy city bridges at several different places.

ROCK RIVER AND MERRIMAC BRIDGES, CHICAGO & NORTHWESTERN RY.

(With inset.)

In its gradual work of replacing by new and heavier structures the old bridges along its lines, the Chicago & Northwestern Ry. Co. has recently completed two bridges, which for different reasons are of interest to engineers, and through the courtesy of Mr. J. E. Blunt, Chief Engineer, and Mr. W. H. Finley, Bridge Engineer of that company, we are able to present illustrations showing the essential features of these structures. The first bridge illustrated—that across Rock River, at Rockford, Ill.,—is of interest for its family history, the general characteristics of which engineers will recognize as typical of the history of many other American railway bridges. The second bridge is interesting on account of the method adopted in erecting it without disturbing traffic.

Rock River Bridge.—The first bridge built to carry the Chicago & Northwestern Ry. across the Rock River, at Rockford, Ill., was completed in 1852, a date at which iron bridges had been used in only a few isolated cases. Indeed, only five years before, in 1847, Squire Whipple, under the title of "A Work on Bridge Building," had presented the first rational discussion of the determination of stresses and proportioning of cross sections of truss members as the science is known to-day. The Howe truss had been known for twelve years and the Pratt truss for eight years, and many important combination wood and iron structures of these two types had been erected, but the era of iron bridges had hardly begun. Located in the West, far from the then existing centers of iron production and with the precedent of past experiences in favor of wooden structures, it was natural that a wooden bridge should have been erected at Rockford. It is not quite so easy to see, however, why a type of wooden structure which even at that early date was becoming obsolete, should have been chosen, for we find this first bridge to have consisted of five 116-ft. and two 106-ft. Burr truss spans with their clumsy trussing and reinforcing arches of wood.

Whatever the considerations determining their selection may have been, these Burr trusses served their purpose for 17 years, when, in 1869, they were replaced by an equal number of Howe truss spans resting on the same foundations. Fig. 1, reproduced from a yellow old photograph taken in 1869, shows this work of reconstruction in progress. At the near end of the bridge is seen one of the old Burr truss spans undisturbed and just beyond is a second truss of the same type but with the arch timbers removed in the process of reconstruction. The far end of the bridge shows a number of the new Howe truss spans. This illustration will be found not uninteresting, too, on account of the single-driver inclined cylinder locomotive and the derrick car being used in the reconstruction work. It may be noted here, also, that this work was done under the immediate direction of Mr. J. E. Blunt, the present Chief Engineer of the Chicago & Northwestern Ry., who was at that time Division Engineer of the Galena Division of that railway.

Fig. 3.—Test of Concreted Trough Floors for Bridges.

The second generation of this bridge, the Howe truss, continued in use until the winter of 1895-6, or altogether 27 years, when it was replaced by the riveted triangular truss deck bridge shown by Fig. 2. This new bridge was placed on the same piers which carried the old Burr trusses of 1852, the only change necessary being the removal of the old capstones and some necessary modifications of the seats. A comparison of the old and new structures shown by Figs. 1 and 2 will suggest many things of interest to the bridge engineer, but with this brief historical introduction we proceed here to the construction of the new wrought iron structure, the grandchild of Rockford bridges. It may be noted here in reference to the use of wrought iron instead of steel that the managers of the Chicago & Northwestern Ry. Co. much prefer wrought iron to steel for bridge work, and state that up to this time they have succeeded in getting it as cheap or cheaper than steel.

The new iron bridge at Rockford is a single-track riveted truss deck bridge consisting of five 120-ft. spans and two 100-ft. spans. Fig 3 shows the general details of one of the 120-ft. spans—actually these spans are 114 ft. 3¼ ins., c. to c. of end pins—and as all shapes and dimensions are given they need not be discussed here. The manner of erecting the bridge deserves, however, brief mention, and to explain it the partial drawings of the falseworks, Fig. 4, are given.

A number of bents were constructed, as shown by the end elevation, Fig. 4. It will be noticed that the top story of this bent passes up inside of the trusses of both the old bridge (shown by dotted lines) and the new iron bridge. For each span the requisite number of these bents, generally seven or eight, were placed and then braced together longitudinally by means of horizontal and diagonal timbers held by bolts. This construction allowed the falsework to be taken to pieces and built up again quickly and easily. Enough falsework was built for three spans and after the completion of the ironwork for these spans the falsework was removed and re-erected under three other spans.

Turning now to the end elevation of the falsework shown in Fig. 4, the method of erection may be explained. After the erection of the bents and their bracing complete, the old Howe truss floor was removed and the track temporarily laid on the bents. The Howe trusses were then torn down and removed with the exception of the bottom chords, which were slid out on the first story cap of the bents and formed a track for the traveler used in erecting the ironwork. The iron trusses being erected with floor beams complete, the temporary floor on the bents was replaced by the permanent floor and track of the new bridge. All the erection was carried on without interruption to traffic. The railway company erected the falsework and tore out the old Howe trusses, Mr. R. C. Sattley, Superintendent of Bridges, Galena Division, having charge of the work. The Wisconsin Bridge & Iron Works, Milwaukee, Wis., built and erected the new iron bridge.

Merrimac Bridge.—The Merrimac Bridge crosses the Wisconsin River at Merrimac, Wis., and the work here described consisted in erecting twelve plate girder deck spans to replace the same number of riveted truss deck spans without delaying traffic, which averaged 18 trains between 7 a. m. and 6 p. m. o'clock during its prosecution. As will be seen from Fig. 5, the supports for these spans were iron towers and as the old truss spans were deeper than the new plate girder spans the towers had to be increased in height. This increased height was secured by the construction shown in Fig. 6, which also shows other details of the plate girder work, floor construction, etc.

To erect the bridge a falsework was erected on each side of three spans, as shown by Figs. 7 and 8. This falsework was so arranged that as soon as three spans of the new structure had been completed it could be removed and set up beside three more spans. On the falsework on one side the new plate girder span was assembled complete. This being done the old span was slid sideways onto the opposite falsework and the new span put in its place. The illustrations show the method of operation in a general way, but further details are given by Mr. M. Riney, Superintendent of Bridges and Buildings, Chicago & Northwestern Ry., in a report of the work to Mr. Wm. H. Finley, Engineer of Bridges for the same company. This report was as follows:

During the erection of the twelve plate girder spans over the Wisconsin River at Merrimac, Wis., the number of trains that crossed the bridge daily between 7 a. m. and 6 p. m. was 18. Work was begun unloading the falsework the last week in September, 1895, and on Oct. 3, 4 and 5, three spans of falsework on both sides of the bridge were raised. On Oct. 5 the iron crew lowered the first girder onto the falsework, and by Oct. 7 the remaining girders and connections for all three spans had been lowered and the floor beams, laterals and stringers put in place. On Oct. 9 the first set of girders was moved onto their permanent position. To allow of this shift the running of trains was so arranged that the time between 2 p. m. and 4 p. m. o'clock was left free from trains. In making the shift the first thing done was to remove the ties from the old bridge. A block and tackle was then hitched to the old span and it was slid bodily out onto the falsework by means of a hoisting engine. The time occupied in doing this was three minutes. The hitches were then changed to the new girder span, blocking meanwhile being placed on the towers to provide for the less depth of the girder span. The new span was then slid into place in about five minutes. The old span was moved about 14 ft. and the new span about 15 ft. from their original positions. Before starting to move the new span the ties had been placed so that all that remained to be done was to put the rails into place. The procedure with the remaining spans was exactly similar and the following statement shows the time occupied in placing each new span complete:

No. span.	Hrs.	Mins.	No. span.	Hrs.	Mins.
1	2	30	7	1	10
2	2	00	8	1	30
3	2	05	9	1	40
4	1	15	10	1	30
5	2	00	11	1	40
6	1	45	12	1	30

Only one train was delayed and that during the change of the first span when the men were new to the work and over careful.

When the three new spans had been set, the next task was to remove the old spans so as to get at the falsework to move it to a new position. Two long pine timbers were placed on timber horses transversely across the car with their ends overhanging on each side of the bridge, Fig. 7. By means of block and tackle operated by a hoisting engine, also on the car, two bents of the falsework on each side of the bridge were picked up and the cars moved along the bridge to the points where the bents were to be set again. Everything possible was handled by a locomotive, hoisting engines, and a wrecking car. The first span was set in place Oct. 9, and the last Oct. 31.

The designs for both this bridge and the Rockford Bridge and also the methods of erection were the work of Mr. Wm. H. Finley, Engineer of Bridges, Chicago & Northwestern Ry. The Merrimac Bridge was built by the Lassig Bridge Works, of Chicago, Ill., and it was erected by Mr. A. B. Carson. The forces of the railway company put in the falseworks and handled them during the work.

THE SAFE THICKNESS FOR ENGINE TRUCK WHEEL FLANGES.*

Your committee is asked to report on the thickness of engine truck wheel flanges, recommending the minimum thickness at which it is safe to allow the leading truck wheels to run.

At the last convention, at Alexandria Bay, a communication was received from Mr. T. J. Hatswell, master mechanic of the Flint & Pere Marquette R. R., asking that this matter of the thickness of engine truck wheel flanges be discussed. It appears that Mr. Hatswell had had a difference of opinion with the Railroad Commissioner of the state of Michigan, arising from an accident on his line by the derailment of an engine at a frog on a perfectly straight track, which was attributed to a thin flange on the engine truck wheel. The wheel in question was steel-tired. The flange of the wheel, measuring by the gage, was 13-16-in., which Mr. Hatswell considered perfectly safe in running. The commissioners fell back on the M. C. B. rules, claiming that they recommended wheels to be condemned with a flange 1 in. in thickness, and that a steel-tired wheel ought not to be rated with a flange thinner than a cast-iron wheel.

We have made rather extended investigations, and find a considerable variance in practice. We find the allowable thickness to vary from ⅞ to 1⅛-ins. in steel wheels,

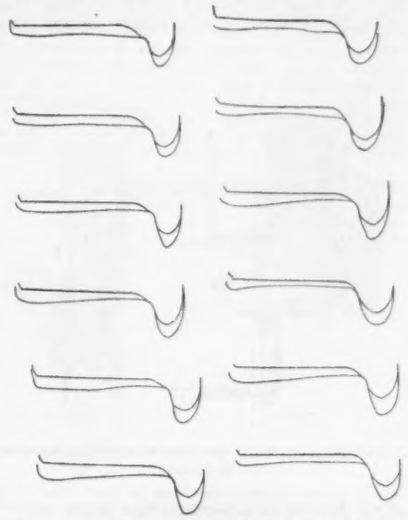


Fig. 1.—Contours of Engine Truck Wheel Tires With Flanges Worn Thin, and Standard Section after Turning, Showing Amount of Metal Required to be Removed.

and from ⅞ to 1 and 3-16-ins. in cast-iron wheels, a range for which there seems to be no good reason. There is a considerable number of mechanics who follow the practice of permitting a thinner flange in steel wheels than on cast-iron wheels, and we confess that your committee started its work of investigation with a bias in favor of this practice. It seemed at first that a steel-tired flange could be worn thinner than a cast-iron flange, inasmuch as in condemning one the reasons were entirely different; that is to say, a cast-iron flange ought to be condemned when it developed wear, on account of its liability to break, whereas a steel-tired flange ought to be condemned when it showed wear, not on account of its liability to break, but on account of its liability to climb the rail through being sharp. We very shortly changed our views of this matter, however, and now think it can be demonstrated very clearly that there should be but one thickness as a minimum for a leading engine truck flange, whether the material is cast iron or steel. In support of this view, we submit tracings that show that by allowing even moderate wear to a steel flange, the life of the wheel will give out much more rapidly, owing to the quantity of tread surface that subsequently has to be turned off and thrown away, in order to produce a standard thickness of flange.

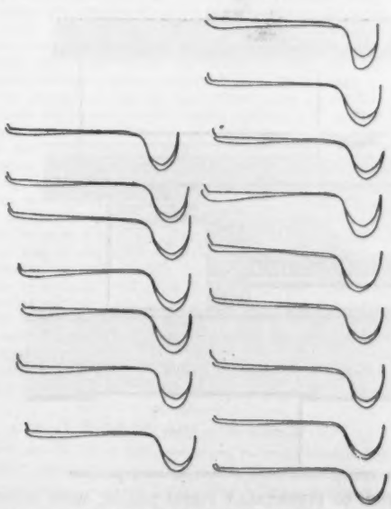


Fig. 2.—Sections Showing Economical Limit of Flange Wear on Engine Truck Wheels.

These tracings show the outlines of a number of coach tires which were taken on the C. B. & Q. Ry. several years ago by Mr. A. Forsyth, master mechanic of that road. We append a letter from Mr. Forsyth, which, with the accompanying drawings, we believe fully demonstrates the correctness of our position.

To sum up, your committee would definitely recommend:

1. That the minimum thickness of leading engine truck wheel flanges should be the same for both iron and steel wheels.

(Note.—In recommending that the steel flange limit be the same as in cast iron, the fact that the strength of steel admits, with perfect security, of a thinner flange has not been lost sight of by your committee. Our recommendation is based purely upon economical considerations as to tire wear.)

2. That the minimum thickness be 1 in., measured at a point ¾ in. from the top of flange, as shown on the appended diagram, Fig. 3.

Pulaski Leeds, G. W. Rhodes, R. M. Galbraith, A. F. Stewart and W. D. Crosman, Committee.

Appendix.

Aurora, Ill., May 18, 1896.

Mr. G. W. Rhodes, Supt. M. P., C., B. & Q. Ry., Aurora:

Dear Sir: Replying to Mr. Crosman's communication attached. Up to 1890 it was our practice on the C., B. & Q. to run steel-tired wheels as long as they could possibly run with safety. This was done with the idea that we were getting more mileage out of the steel tires by so doing. During the year 1889, I took contour lines from every steel-tired wheel that came to the shop for tire turning, and in April, 1890, the matter was brought to the attention of the C., B. & Q. Master Mechanics' Association, and blue prints of 171 tires as they arrived at the shop, and the amount of metal that had to be turned off the tread in order to make a good flange, were presented at that time.

In order to illustrate this, I have selected from these contour lines (Fig. 1), and present on the enclosed

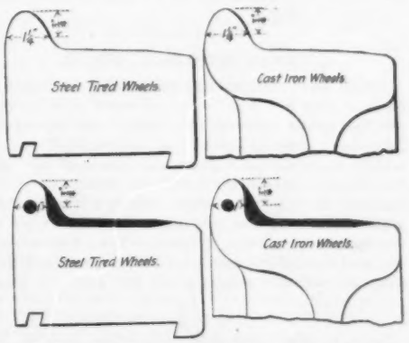


Fig. 3.—Standard Flange and Minimum Flange Thickness Recommended for Engine Truck Wheels.

drawing twelve extreme cases which show the enormous amount of metal wasted from the tread of the steel-tired wheels by allowing the wheel to run until it has a very thin flange.

On the second drawing (Fig. 2) I have shown selected contour lines of sixteen steel-tired flanges that had commenced to develop flange wear. At our Master Mechanics' meeting it was decided that it was not economical to allow flange wear on steel-tired wheels to get any worse than is shown on this drawing.

A. Forsyth, Division M. M., C., B. & Q. Ry.

THE COSTA RICA RAILWAY.

From a report by Mr. George E. Church, M. Am. Soc. C. E., one of the directors of the Costa Rica Ry. Co., of London, we take the following brief description: The line extends from Limon, on the Atlantic coast, to Alajuela, 117 miles, with a branch 20 miles long to Guapiles. The grades are from 1½ to 4%, the latter being at the summit of the range, and the curves are from 12 to 20°. There are 143 bridges, with an aggregate length of 10,702 ft., which is an indication of the great amount of waterway to be provided for floods, etc. All the bridges are of iron, with a minimum span of 20 ft., and there are 25 bridges with lengths of 129 to 620 ft. Floods and landslides cause much damage to the railway and its structures.

The line has a gage of 3 ft. 6 ins., and is laid with 50-lb. rails on the main line and 40-lb. rails on the branch. Between Limon and San Jose (the capital city) there are 99,500 wooden ties, of which 27,500 are of lignum vitae (estimated to have a life of 15 years on the Panama R. R.), the remainder being of Colombian and native hard wood, which requires renewal in a few years. All the

*A committee report presented at the annual meeting of the American Railway Master Mechanics' Association.

other ties are of steel, of which 20,130 were on hand for renewals in June last. It is recommended that all renewals should be made with steel ties, except that lignum vitae should be used on the first 12 miles, as the action of the climate and the sea air is very destructive. The steel ties, after 7 years' use, show a wear of about ⅛-in., under the outer flange of the rail.

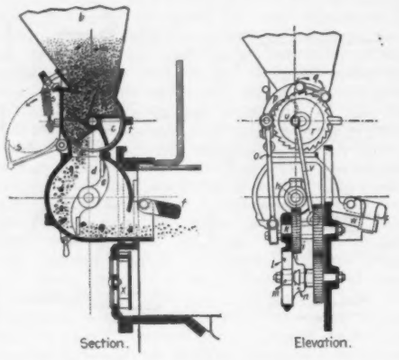
There are 22 locomotives, of six or seven different types, and it is considered that 16 mogul engines and 2 six-wheel switching engines could more economically handle the traffic. At present large American engines (from the Baldwin Locomotive Works) are used on the heavy divisions, hauling the same trainloads which the smaller English engines haul on the other divisions. There are 37 passenger cars, of various types, and the small English cars are considered inferior to the American cars on account of their greater proportion of dead load. The freight equipment aggregates 284 cars, and here again the American cars, with a capacity of 20 tons and over, are considered to give more economical service than the small English cars of 8 and 10 tons capacity. These latter, however, are at present preferred for certain traffic. It is recommended that all new cars should have iron or steel sills, as wood has so short a life in this climate. At Limon there is a wooden pier 930 ft. long, 50 to 70 ft. wide, along which two tracks are laid. The piles are subject to rapid destruction by the teredo navalis, and a new iron pier, at a different location, is proposed. Some particulars of the early history of this railway will be found in our issue of Feb. 16, 1889.

A GERMAN MECHANICAL STOKER.

That our readers interested in mechanical stokers may see what is being done in that line on the other side of the water, we reproduce herewith illustrations of a mechanical stoker which is being placed on the market by the "Sachsische Maschinenfabrik zu Chemnitz." We venture to say that most American engineers, after examining the accompanying drawings of the apparatus, would pronounce it an unmechanical and absurd contrivance; but, notwithstanding this, if its manufacturers tell the truth in their circular, it seems to be giving a very good account of itself in service, being in use in some 150 different establishments, many of which have from 5 to 14 boilers equipped with it.

The makers state that either anthracite or bituminous coal may be used, but the kind best adapted is a nut coal, with pieces varying from ¼ to ¾ in. in size. By changing the speed of the rotating shaft, however, it is said that pieces as large as 2¼ ins. may be stoked. The feed is adjustable to suit different rates of combustion.

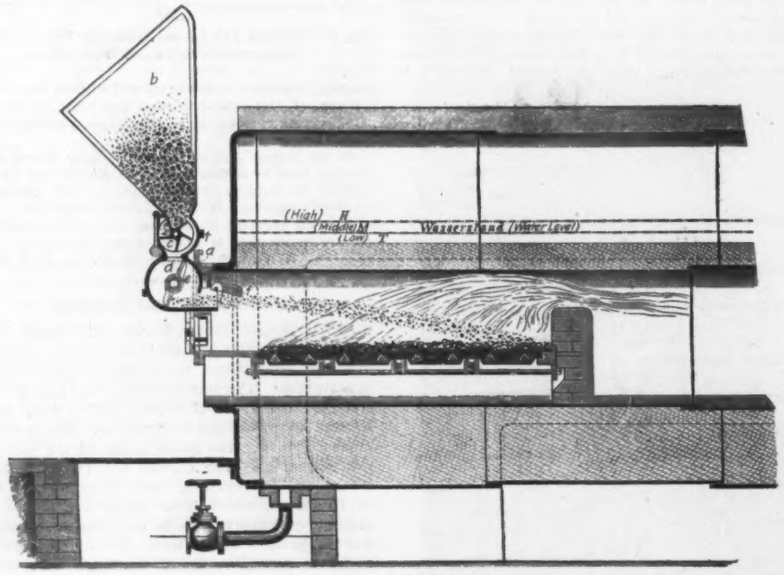
The general principle of the device is evident from the accompanying drawings. The coal is thrown into the furnace by wings on a rapidly revolving shaft, and is fed to that shaft in measured quantity by a slowly turning wheel at the bottom of a hopper. One would suppose that clogging and breakage of these two shafts would be too common to make the machine a success; but if that is the case how do so large a number come to be in use?



Cross Section and Front Elevation of Operating Machinery of Stoker.

It will be seen that the stoker is designed for attachment to an internally fired boiler; and it certainly is an attractive feature that none of the moving parts are directly exposed to the fire. Apparently, also, it can be attached to the front of an ordinary boiler with very little difficulty.

It will be seen that the stoker has firedoors of its own, fitted with slides; and as the doors remain closed, it is claimed that a smokeless combustion may be obtained through suitable manipulation of the slides and the chimney damper.



A GERMAN MECHANICAL STOKER. LONGITUDINAL SECTION OF INTERNALLY FIRED BOILER, WITH STOKER ATTACHED.

Made by "Die Saechsische Maschinenfabrik" Zu Chemnitz.

We leave American stoker manufacturers to decide whether this apparatus is so poor that the Germans adopt it for lack of something better (in which case the American stoker makers will do well to pay attention to their German export trade); or whether it is so excellent that it ought to be introduced in this country.

STEEP GRADES ON ELECTRIC RAILWAYS.

By S. L. Foster.

In 1892 railway men began to realize that heavier motors were needed. The forerunner of the latest series parallel controller appeared on the scene and the cost per mile was brought down to a more reasonable point. These powerful motors rendered feasible grades that it would have been unwise to operate with the old equipment. The toothed armature cores, instead of smooth cores, and the protected field spools, reduced the item of motor repairs, and a large amount of power formerly wasted at starting was saved by the new controllers. In San Francisco the unusual grades encountered led to the use of two 25 HP. motors on each single truck car.

These 25 HP. motors are far in excess of what is required to propel the cars on the level, and we thus see already that some of the penalties for operating electric cars on heavy grades are the necessity of transporting heavier motors than are needed on the level, the attendant lower average car efficiency and the increased rail joint abuse.

It is hardly necessary to note that single truck cars have been found to be better than double truck cars for heavy grade work as in the former the motors are given the benefit of all the adhesion the weight of the car can give, while in the latter some of this weight is supported by the four wheels that do not act as drivers for the car.

There is a misconception in some minds as to the power that is really required by an electric car on a grade. The formula used in determining the force required to propel a vehicle shows that when on a grade this force increases rapidly with the grade when the speed remains the same. But the speed of an electric car does not remain the same on a grade as on the level. The motors are only capable of a certain effort and as on a grade the car not only has to be advanced horizontally, but also raised vertically at the same time, the work to be done is increased and the car speed decreases until it is within the power of the motors.

Another feature of grade climbing—the freedom from wagon interference is often overlooked. On a road where heavy grades prevail very little wagon traffic is met, and the slow running and frequent stops and starts so prevalent on a level line and so wasteful of power are absent. When a car starts up a grade it has an uninterrupted run to the end and its short pieces of level track are usually clear. The result of these compensations is that the average amount of electrical energy absorbed on 1,000 car miles covering seven consecutive days on a level city line is but 50% less than the average on 1,000 car miles on a city line in which several 10 and 12% grades exist. The level line is 24,000 ft. long where there is a total rise of but 142 ft. and the other was 16,000 ft. long and comprises two hills. The line rises 186 ft. to the top of the first hill, descends 92 ft. and rises to the second hill top 143 ft. The same style of cars and motors was used in both cases.

When the new series parallel controllers came out, instructions were given to use only the series notch on heavy grades as it was more economical to run the motors in series than in multiple. Let us see what the basis of this advice was and its value. On grades over 6% about two times as much current is used and over twice the speed is attained by the car when the motors are run in multiple as when run in series. This excessive flow of current causes an increase in sparking at the brushes, sends the armatures to have the commutators turned sooner and the greater speed on the grade wears the bearings and gearings more rapidly. From the standpoint of the repair shop, the series combination is thus seen to be the cheaper.

From the standpoint of the power house engineer, too, it is better for cars to be run up hill on the series notch as the power plant can handle twice as many cars that are running on the series notch as if the cars ran on the multiple notch. The lines containing heavy grades are the bugbear of the engineer on account of the abnormal fluctuations in load due to the cars climbing the grades on the multiple notch. Where the plant is nearly loaded, this sudden occasional call for four times the normal current often results in the whole line being cut out in order to assure current for more important lines.

From the standpoint of the investor, the series notch is preferable, as when cars are run up the grades with the motor in multiple the system must be not only equipped with boilers, engines, generators and feed wire, of double the capacity that would be required if the series method of running the motors were used, but this double capacity must be running and ready at all times, as it is not a case of a load coming on at 7 a. m. and 5 p. m., but it appears at regular intervals through the day and must be provided for.

From the standpoint of the watts per car mile, or the coal pile, however, the multiple notch is found to be slightly cheaper. On grades over 6% under ordinary conditions, single truck cars equipped with two 25 HP. motors were found to require, when the motors were run in multiple, from nothing to 14% less expenditure of power than when the motors were run in series.

The current will be more when in multiple, but the

*Extract from a paper read at the first annual meeting of The California Street Railway Association.

time will be less than in an inverse ratio to the current or, what is the same, the speed will be more than in a direct ratio to the current. For example, on a given grade two times the current is absorbed and 2.6 times the speed is attained. Thus the power is less at the multiple notch. This saving, however, is not worthy of consideration, as it is undoubtedly more than counterbalanced by the loss at the generators, due to inefficient running at under load most of the time. This saving on a 14½% grade amounts to 1¼ K-W. hours per mile of grade run.

In other words, as roads are usually built with but few and short heavy grades and the rest of the lines more nearly level, the use of the multiple notch involves a slight saving for a few moments of each trip and a waste in the form of interest of money and unnecessary coal burned for inefficient generators for the rest of the time.

On a line where a number of tests were made the saving was for 6.2%, and the waste for 93.8% of the running time. The series notch is thus seen to be the more economical. Ordinary mechanical reasoning teaches us that the amount of power required to propel a car up a grade is independent of the speed. If the speed is slow the force required is less, but the time during which it is exerted is longer. If the speed is rapid the force is greater and the time less, so that the result is the same in either case. The explanation of this disagreement between theory and the facts is found when we consider the relative car efficiencies at the two notches. The efficiency is higher at the multiple notch on a heavy grade because the work done by the motors approaches more nearly their rated capacity where their efficiency is a maximum.

This greater economy at the multiple notch held good under the conditions of the tests made, only on grades above 6%. On such a grade the power consumed is the same at the series as at the multiple combination, while on lesser grades and on the level the series is the more economical notch at which to travel a given distance. The tests were made under ordinary conditions of load and voltage. Of course, every railway manager must decide according to his local conditions which is the larger, the value of the coal saved by the use of the multiple notch, or the extra expense for repair work on armatures due to the quadrupled flow of current, plus the interest on the additional station capacity rendered necessary in order to safely handle the sudden heavy calls for current made by the hilly lines, plus the interest on the extra amount of feeder wire needed to keep up the voltage when from three to four times the current usually used on the level is called for. There is still another expense to set against the saving in coal and that is the item of lamp breakage. If feeders of sufficient size are run to the hilly portions of the line so as to hold up the voltage for the few moments during which the cars are climbing at the multiple notch, these feeders will be too large for the line the rest of the time when the cars are not climbing, and the voltage will rise and as the lamps will be running up over normal candle power most of the time, their life will be shortened considerably.

The question of requiring more cars when the series notch is used on grades in order to secure the same headway will not come up unless the line is run with no layover at the ends. On the line tested comprising 33,000 ft. of single track and having five heavy grades each way, 1½ minutes only would be lost each half trip by changing from the multiple to the series method of climbing heavy grades or three minutes to made up in 50, the time of a round trip.

It is frequently asked what the steepest grade is that can be ascended by an electric car, and the question is as often left unanswered because the questioner cannot state the exact coefficient of friction between the car wheels and the rails.

It is easier and fully as much to the point to tell of what steep grades have been climbed and to call attention to the fact that it is not a question of how steep a grade can be climbed, but how steep a one can be safely descended. In San Francisco cars are operated successfully both ways on a 14.54% grade, and on the Piedmont road in Oakland on a 14¼% grade up and down. In Seattle, Wash., on Rainier Ave., by the help of sand a single truck car climbed a 16.85% grade 300 ft. long, but in this case it is not dared to allow a car to descend without an outside check on its speed.

Some motormen have devised a method whereby they can come down heavy grades rapidly, have the brakes on fairly hard and yet not slide the wheels. This result is produced by putting the controller on the series notch while the brakes are set. The maximum braking effect has been found as the result of an elaborate series of tests made by European engineers, to be produced by applying the brake shoes at a pressure just under the skidding point. In case the wheels slide, the brake shoes should be released at once, the wheels allowed to revolve and be then gripped again. The motormen referred to have found that by the use of the motors, they can hold the car braked at that point of maximum retardation just short of skidding and can keep the car wheels free from slipping, while maintaining a higher rate of speed than is possible when not using current in conjunction with the brakes. The idea of using power while descending grades, however, is just the reverse of what all street railway men have been seeking to realize, namely, how to recover, while descending, some of the power consumed while ascending. It also seems most dangerous for motormen to get into the habit of using current while descending a grade, lest in case an emergency arise, they continue to advance the controller instead of throwing it back to "off" before reversing. When at the series notch it is impossible to reverse the motors. The controller handle must first be thrown "off." If the controller is on, it necessitates one more operation before the car can be stopped, and in an emergency the time occupied for this extra move is extremely valuable.

It can perhaps be plausibly argued that a car can be stopped more quickly by causing sliding wheels to rotate than by leaving them sliding, from a consideration of the tests mentioned above. Here it was found that the pull per ton required to tow a car with the brakes set decreased from 42 lbs. to 5 lbs. as soon as the wheels slipped. Conversely it might be claimed that if the wheels were turned when slipping the car speed would be checked. It would be a good deal cheaper, however, to make these wheels turn by slacking off the brakes than by trying to do it by using current.

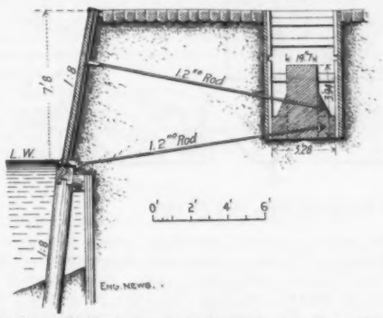


Fig. 1.—Quay Wall of Iron and Concrete on the River Spree, Berlin, Germany.

The problem of ascending grades where electricity forms only a portion of the power required for the work is solved in this locality in three typical ways—at Mt. Lowe, near Pasadena, Cal.; in San Francisco, on the Fillmore St. grade, and on Rainier Ave., in Seattle, Wash.

At Mt. Lowe two cars are permanently attached at opposite ends of a cable that passes around a winding drum in the power house at the top of the grade. The force of gravity on the descending car aids the ascending car in its ascent. The track construction is three rail with a turnout at the center of the route where the cars pass each other. The system is controlled entirely from the power house above. A positive difference in loads is made up by a stationary electric motor actuating the winder, and a negative difference is offset by a brake on this winder. Here grades as high as 68% are surmounted.

On Fillmore St., in San Francisco, we have a practical double track street railway proposition. The descending car assists the ascending car on the same principle as at Mt. Lowe. The positive difference between the loads of the two cars and the friction of the gearing, cable, etc., is made up by the use of the motors on one car; any negative difference being controlled by a band brake on the tail sheave on the hill top. When each of the two cars ends its upward or downward course, it is quickly released from the cable and proceeds on its trip. The grade here is 25.54% and about 25 HP. is used to work the whole mechanism including both cars. In this case two cars—one descending and one ascending—are essential for the working of the device.

At Seattle the line is single track, while under it is a second track in a conduit. The passenger car runs above and a load of pig iron as a counterbalance below. A descending car pulls the car of iron up to the top of the hill on to a bit of level track where it stands. The next ascending car by starting up and pulling up the cable, which is endless, starts this counterbalance car down and receives assistance from its descent in climbing the 17% grade.

Here one car only is needed at a time, but it must be always going in the right direction.

A QUAY WALL OF IRON AND CONCRETE.*

The use of steel and concrete in combination is rapidly extending in this country, but German engineers are making still more bold experiments in this direction, many of which promise to be valuable improvements upon older practice. We show herewith a quay wall recently constructed along the Spree in Berlin and illustrated and described in the "Centralblatt der Bauverwaltung."

On top of a row of piles, driven into the river bed, are placed battered iron posts from 1.5 m. (5 ft.) to 2 m. (6 ft. 6 ins.) apart, to which plates of the well-known Monier construction are connected; they are from 0.6 m. (23⅝ ins.) to 1 m. (39⅜ ins.) high, and from 7.5 c. m. (2 15-16 ins.) to 6 c. m. (2⅜ ins.) thick. They are lined with cement mortar on the inside, and act as horizontal beams. The tops of the battered posts, on a level with the street surface, are braced by an angle iron, or some other light shape, and each post is anchored by two rods, one at the base and the other at a point above the center of pressure of the back filling, and slightly more than two-thirds of the height of the iron post, which gives, approximately, an equal stress upon the rods.

Two different methods of anchoring these rods are shown; in the one they pass through and are held by nuts and washers on the back of a continuous block of concrete; in the other case, which is the cheaper and easier method, an iron plate fastened to a frame of channels is used in place of the concrete.

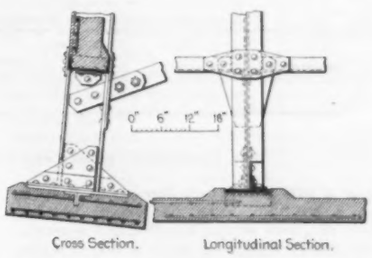


Fig. 2.—Foundation Plates for Iron and Concrete Quay Wall.

All iron that is placed under ground is protected by a coating of cement mortar 1 to 3; on the side exposed to the water the iron is cleaned and oiled.

Numerous experiments have proved that Monier plates offer a large resistance to impact; and a further advantage in this construction is the smooth and uninterrupted surface presented against the action of exterior forces, The wall at Berlin has been built as an experiment, and the observations during the last five years warrant the conclusion that it possesses a considerably greater durability than one built of wood, while its total cost per square foot of wall surface, including all incidentals, amounts to only about one-third more. These remarks apply to the construction shown in Fig. 1.

As to the expense of maintenance, actual experience is, of course, still wanting; it is well known, however, that cement offers an excellent protection to iron against rust, and that the Monier plates show satisfactory weather resisting qualities, and that, therefore, this item may be expected to be low. It is also to be assumed that the cost of future similar construction will be reduced, and the details simplified. The shore wall is perfectly tight, and proper drainage of the back-filling must, therefore, be provided.

Where it is not convenient to drive piles, a base of Monier construction, as shown in Fig. 2, and broadened out sufficiently to distribute the pressure, may be used. The baseplates retain moderate dimensions even with soil of very small compressive resistance, and are, therefore, to be especially recommended for such cases.

A mathematical investigation of the stresses in the front plate, rods and anchor plate, indicates that a considerable saving in material may be secured in carrying out similar work in future.

*Abstracted from the "Centralblatt der Bauverwaltung." By O. J. Marstrand, M. Am. Soc. C. E.

GARBAGE DISPOSAL AT TACOMA AND SEATTLE, WASH.*

By A. McL. Hawks., Jun. Am. Soc. C. E.

Experience and Practice at Tacoma.

The population of Tacoma by the last census was 36,006, but garbage and refuse is collected from only about 15,000 people. Garbage collection

*Prepared from information collected by Mr. Hawks for Mr. Rudolph Hering, M. Am. Soc. C. E., and published with the consent of Mr. Hering.

is under the control of the Board of Public Works, the city's carts collecting street sweepings and the garbage and ashes being collected together by private carts. The garbage in the residence district is supposed to be collected twice a week and in the business district, and from boarding houses and hotels, daily. Ashes are removed from one to three times a week.

The approved form of receptacle for ashes and garbage is a galvanized iron can about 2 ft. in diameter, 3 ft. high, with reinforced bottom, heavy iron rim, two strong handles and a cover. Nearly all covers disappear after a few months, as they are not fastened to the can. The cans must be placed at the curb line in the business section and on the line of the alley in the residence district of the city.

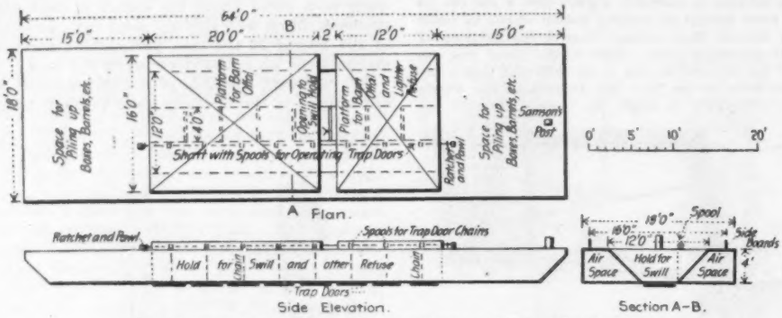


FIG. 1.—GARBAGE SCOW USED AT TACOMA, WASH., 1890 TO 1893.

Ordinary wagons are used for collecting garbage and ashes. Dump carts would, of course, be preferable. The garbage wagons are supposed to be water tight, with canvas covers, but such covers are not ordinarily used. They are drawn by two horses and accompanied by only one man in the residence, and by two in the business district, the hauls for these districts being respectively 1½ and ¾ miles. The wagons used cost from $75 to $125 each.

The only record of the amount of garbage, ashes and other refuse collected is for the year ending with July, 1895, the figures being taken from the books of the Northern Pacific Railroad Co., which at that time was hauling the garbage from the city. The record, in tons, is as follows:

August	295	February	250
September	290	March	230
October	330	April	240
November	320	May	90
December	310	June	156
January	300	July	108

Total for the year.....2,979 tons.

The composition of the material collected varies in winter and summer, as follows, the figures being percentages:

	Winter.	Summer.
Ashes	50	20
Barn refuse	25	50
Other material	25	30

The yearly cost of gathering the garbage may be estimated at $3,500; of hauling by train, $3,250; of spreading on land, $600; making a total of $7,350, when the garbage was shipped by rail and hauled to and spread on farm land. Disinfection of the garbage receptacles, wagons and cars is not practiced. The garbage weighs about 30 lbs. per cu. ft. in summer, dry, and 45 lbs. in winter, soaked.

The history of garbage disposal at Tacoma has been as follows:

In the summer of 1890 a garbage crematory was erected, but no information is available regarding its character and cost, further than a portion of the structure still standing, which indicates an ordinary furnace, and four fragments of bills from which the cost may be estimated as about $6,000. On Aug. 21, 1891, a contract was made for the operation of the crematory for a year at $1,051, but on Nov. 1, after several weeks of unsuccessful trial, the contract was cancelled by mutual agreement.

On Nov. 1, 1890, a contract was let for towing the garbage on a scow from the city dock about three miles out to deep water. The contract price was $550 a month for eight months, for six trips a week. The capacity of the scow was from 60 to 100 cu. yds., according to the method of loading, the weight being perhaps 1,000 lbs. per cu. yd. The contract was renewed on July 1, 1891, at $313 per month, and on July 1, 1892, for $219 per month for the same service. The latter rate continued until Sept. 15, 1893. The design of the scow is shown by Fig. 1.

After some months of scow service complaints arose that the lighter refuse and carcasses of animals lodged on the shores. The nuisances thus occasioned was mitigated through a part of the year by gray sea gulls, which from September to June followed the scow by thousands and picked up the floating matter. During the summer, however, the gull goes north, and in 1893, the complaints became so frequent and insistent that a change was made.

In September, 1893, a contract was entered into with the Northern Pacific Railroad to haul the garbage and street sweepings to Hillhurst, 16 miles distant, for $270.83 per month, or $3,250 per year. Farmers unloaded the wagons and carted the garbage about ¾ mile to their farms for fertilizing purposes. A man at $1.50 a day was stationed at the side track to unload the cars and load wagons, when at hand; at other times he sorted the material. Combustible material was thrown into one pile; tin cans, iron, etc., were thrown into another and afterwards shipped to a smelter where $7.50 a ton was paid for it; the fertilizing material was spread upon land at the rate of 36 loads, of 100 cu. ft. each, per acre the first year and 18 loads the second.

From September, 1893, to April, 1894, the garbage was put on the farms as fast as received, the cost of cartage and spreading being 30 cts. per wagon load, excluding, and 35 cts., including, the sorters' wages. Between April and September, the farmer's busy time, the garbage was sorted and then stacked at the side track. This heap was not very offensive, no odor being perceptible at 60 to 75 yds. There was no farmhouse within ¼ mile and no complaints were made. A part of this heap was carried over to the summer of 1895, without offense. The heap would, of course, steam and give off odor if broken into.

The soil upon which the garbage was placed was a rather poor, sandy loam, which without garbage would yield about 1¼ tons of "green oat hay" or 8 to 12 bu. per acre of oats. With garbage the first year the yield was 3½ tons of hay, or 52 bu. of oats per acre. The second season was a dry one, but the yield even then was 2¾ tons of hay and 42 bu. of oats, while neighboring fields were giving but one ton of hay and 7 to 10 bu. of oats.

A comparison of the yield from 30 acres in hay and 10 in oats for two years, with and without garbage, based on the above figures, shows a gain of $474, or $237 a year, in favor of the land receiving garbage, while there would be a benefit for a few years after through an improvement in the soil. The farmers estimated that twelve loads per acre would keep the land up to the standard for the third and succeeding years, which by decreasing the cost would, of course, increase the profit.

If the use of garbage for low-priced crops shows such favorable results might it not be so profitable for market-gardening as to make it worth while for the gardeners to haul it from the city?

The garbage cars used by the Northern Pacific were of two types. Fig. 2 is a section of the older form, which was simply the common self-dumping ash car, modified a little and made larger. A few trips demonstrated that this car could not be loaded to its tonnage capacity with the light material to be carried and that the doors were too small for the easy removal of dead horses. Therefore the new type, Fig. 3, was adopted, which is simply a huge box about 7½ × 27 × 4 ft. 10 ins., inside measurement, having three doors on a side, each giving a clear opening of 4⅓ × 8¼ ft. Car-

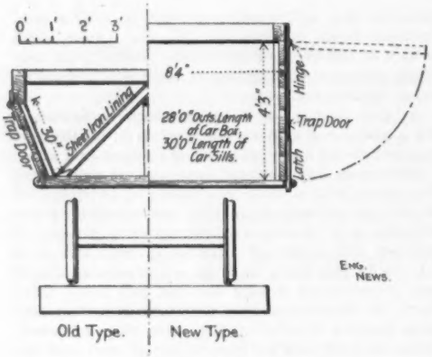


Fig. 2. Fig. 3.

Old and New Types of Garbage Cars at Tacoma, Wash.

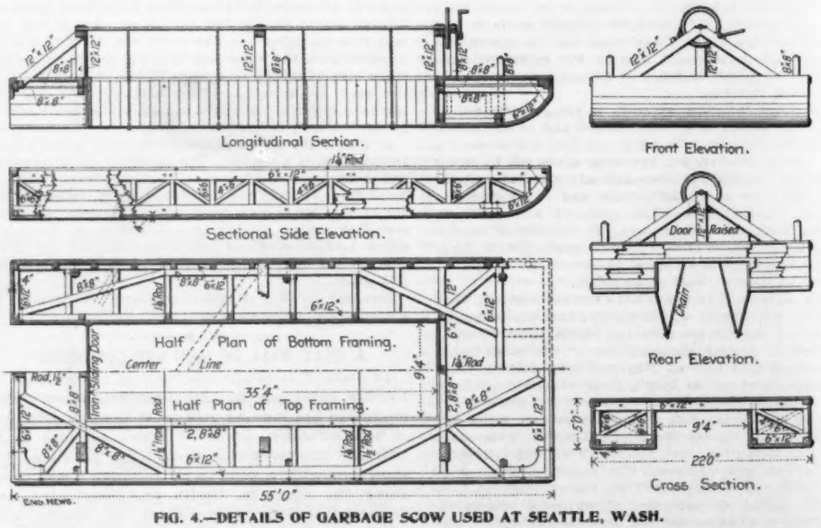


FIG. 4.—DETAILS OF GARBAGE SCOW USED AT SEATTLE, WASH.

casses can be dragged from these cars by means of a horse and rope and the other matter can be discharged by means of a scraper within the car, moved by a team on the ground.

With the completion of a bridge in August, 1895,

the city changed its method of refuse disposal, using the material for making a permanent roadway on the flats. At first the garbage was dumped here with the other material, taking care to keep the worst matter at the bottom. This not proving entirely satisfactory the "swill" is now taken to the "piggeries" by farmers and the remaining matter used for filling. Only one man is kept at the dump. The "hard times" has made a great reduction in garbage of all sorts, especially in "swill" from houses. Where the removal of the latter was once a source of expense to the householder, farmers will now remove it without charge, or even pay a small sum for it. In a few cases stable refuse is taken for fertilizing purposes by farmers living near the city.

Garbage Disposal at Seattle.

The collection of garbage at Seattle does not follow notably dissimilar lines from the system at Tacoma. Householders pay from 50 cts. per month for weekly, to $2.50 for daily, collections. The population served is about 20,000; the census of 1890 showed about 43,000 inhabitants.

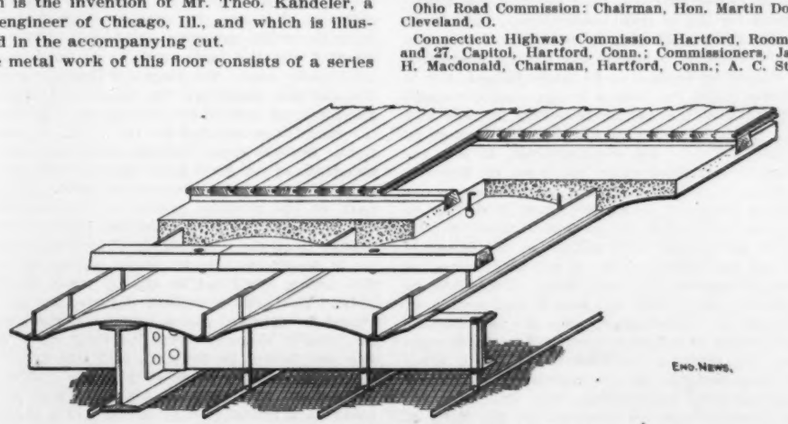
Prior to 1889 no regular system of garbage and refuse disposal was in use. Since the great fire of that year these wastes have been dumped in Puget Sound, requiring a three-mile tow. The refuse is somewhat heavier than at Tacoma and is dumped in deep water, as there, but still it gives trouble along the shores.

About 15,000 tons per year are dumped in the Sound at a total cost of $97 per month, or $1,164 a year, which is about 8 cts. per cu. yd. The form of garbage scow used is shown in detail by Fig. 4.

THE "CHICAGO" FIREPROOF FLOOR.

The development of a safe and economical floor system seems to have attracted the attention of inventors to a greater extent than any other feature of fireproof building construction. Hardly a month passes that some new design is not presented to appeal for the favor of builders and architects, until now it has become a somewhat difficult task to carry in mind the different designs in actual use, to say nothing of the thousand and one which have only reached the dignity of letters patent. One of the latest floor systems which has been called to our attention is the "Chicago floor," which is the invention of Mr. Theo. Kandeler, a civil engineer of Chicago, Ill., and which is illustrated in the accompanying cut.

The metal work of this floor consists of a series of steel bars, about 5 ft. long, and 3½ ins. wide, which are set vertically and spaced 2 ft. apart. To these bars are fastened 2×3-in. beveled wooden nailing strips, and between them are sprung sheet-iron arches, having 2½ ins. rise. This metal work complete is made in the shops in sections 5 ft. wide and 10 ft. long. In the building the sections rest on the floor beams and stringers, as shown, and are covered with concrete. The protection from beneath is secured by a suspended ceiling of fireproofing as shown.



THE "CHICAGO" FIRE-PROOF FLOOR SYSTEM.
Theo. Kandeler, C. E., Chicago, Ill., Inventor.

The claims for this floor are perhaps best stated in its designer's own words, as follows:

The safety of this floor does not depend on the quality of the concrete used, as all carrying parts, up to the floor strips, are steel, and can be proportioned with equal safety for the heaviest and for the lightest loads. If the floor strips should burn out, the concrete arch having a resistance of 50 lbs. per sq. in. would carry a load of 500 lbs. per sq. ft. All work essential to the strength of the floor is done in the factory where its quality can be perfectly controlled. The sections are opened for inspection before they are put in their places. Any amount and quality of fireproofing can be fastened above or below the floor, so that any degree of safety against fire may be obtained. The lightness of the floor follows from the exclusive use of steel for carrying purposes. The concrete is put in merely for fireproofing and deafening, therefore its quantity and weight may be reduced to a minimum. The quickness of construction is possible because all the slow work is done at the factory. This work may begin as soon as the plans of the building are far enough advanced to determine the dimensions of the floor sections, then the sections will be ready when the steel beams, which support them, are in place. The cheapness of our floor is practicable because 90% of the work in its construction is done at the factory, and factory labor is much cheaper than outside work. Another point is the lightness of our floor, which cheapens the steel I-beams, the columns and the foundations of any building in which the floor is used.

Mr. Kandeler calculates that the cost of this floor, taking into account the reduced weight of columns, I-beams, etc., will be 35½ cts. per sq. ft., as compared with 43½ cts. per sq. ft. for a tile floor.

HIGHWAY COMMISSIONS AND ASSOCIATIONS.

At the present time, when so much work is being done in road improvement and in promoting the construction of good roads, a list of the associations interested in highway work, will be of interest to many of our readers, and we therefore publish the following list, which has been kindly furnished us by Mr. M. O. Eldridge, Acting Chief of the Road Inquiry Bureau, Department of Agriculture, Washington, D. C.

Wisconsin League for Good Roads, 505 East Water St., Milwaukee, Wis.—Pres., Thomas M. Blackston, Sheboygan, Wis.; Secy., Otto Dorner, Milwaukee, Wis.; Treas., John Johnson, Milwaukee, Wis.; First Vice-Pres., Lucius Fairchild, Madison, Wis.; Second Vice-Pres., W. D. Hoard, Fort Atkinson, Wis.; Third Vice-Pres., A. Cressy Morrison, Milwaukee, Wis.; Directors, W. H. Rogers, Madison, Wis.; Wm. E. Crater, Plattville, Wis.; Thos. W. Spence, Milwaukee, Wis.; C. C. Rogers, Milwaukee, Wis.; John C. Koch, Milwaukee, Wis.; A. K. Hamilton, Milwaukee, Wis.

Board of Highway Commissioners, Burlington, Vt.: Chairman, Oscar L. Hinds, Burlington, Vt.; Secy., J. W. Votey, Burlington, Vt.; Marcus Peck, Brookfield, Vt.

Ohio Road Commission: Chairman, Hon. Martin Dodge, Cleveland, O.

Connecticut Highway Commission, Hartford, Rooms 25 and 27, Capitol, Hartford, Conn.; Commissioners, James H. Macdonald, Chairman, Hartford, Conn.; A. C. Sternberg, Hartford, Conn.; Wm. R. McDonald, Hartford, Conn.

New Jersey Road Improvement Association: Prest., Clayton Conrow, Cinnaminson, N. J.; Vice-Pres., C. C. McBride, Elizabeth, N. J.; Secy. and Treas., E. G. Harrison, Asbury Park, N. J.

Iowa Road Improvement Association, Clinton, Ia.: Pres., E. H. Thayer, Clinton, Ia.; Secy., O. L. F. Brown, Des Moines, Ia.; Treas., C. B. Worthington, Des Moines, Ia.; Directors, 1st Dist., William Steyh, Burlington, Ia.; 2d Dist., Peter A. Dey, Iowa City, Ia.; 3d Dist., J. M. Muncey, Jesup, Ia.; 4th Dist., Wm. Larabee, Clermont, Ia.; 5th Dist., James Yuill, Cedar Rapids, Ia.; 6th Dist., Chas. F. Blake, Ottumwa, Ia.; 7th Dist., J. G. Barryhill, Des Moines, Ia.; 8th Dist., W. O. Mitchell, Corning, Ia.; 9th Dist., J. C. McCabe, Logan, Ia.; 10th Dist., G. L. Tremaine, Humboldt, Ia.; 11th Dist., H. C. Wheeler, Odebolt, Ia.

Virginia State Good Roads Association, Richmond, Va.; Pres., Joseph Bryan, Richmond, Va.; First Vice-Pres., Chas. E. Asburner, Brook Hill, Va.; Secy. and Treas, H. W. Anderson, "Times" Building, Richmond, Va. Vice-Presidents, 1st Dist., Orris A. Browne, Cape Charles, Va.; 2nd Dist., J. E. Booker, Suffolk, Va.; 3d Dist., B. B. Munford, Richmond, Va.; 4th Dist., Chas. T. Lassiter, Petersburg, Va.; 5th Dist., Geo. Young, Sutherlin, Va.; 6th Dist., H. A. Gillis, Roanoke, Va.; 7th Dist., H. L. Lyman, Charlottsville, Va.; 8th Dist., Geo. W. Barbour, Somerset, Va.; 9th Dist., H. C. Stuart, Elk Garden, Va.; 10th Dist., Lyman Chalkley, Staunton, Va.

Bureau of Highways, Sacramento, Cal.: Commissioners, R. C. Irvine, Marsden Manson, J. L. Maude and E. Marion Wolf (Clerk), all of Sacramento, Cal.

Massachusetts Highway Commission, 15 Court Square, Boston, Mass.: Commisioners, G. A. Perkins, Boston; Nathaniel S. Shaler, Boston; William F. McClintock, Boston; Charles Mills, Civil Engineer, Boston.

New York State League for Good Roads, Rochester, N. Y.: Pres., Gen. B. F. Tracy; Vice-Pres., W. Austin Wadsworth; Treas., S. S. Howland; Secy., John A. C. Wright, all of Rochester, N. Y.

Directors: Thomas R. Proctor, Utica, N. Y.; Hon. Wm. Cary Sanger, Albany, N. Y.; Warham Whitney, Rochester, N. Y.; J. R. Roseveit, Hyde Park, Dutchess Co., N. Y.; Frederick Bronson, 76 Wall St., New York city; John C. Churchill, Oswego, N. Y.; Paul Tuckerman, Tuxedo, N. Y.; Arthur E. Clarke, Batavia, N. Y.; Winthrop Chandler, Barrytown, Dutchess Co., N. Y.; Chas. A. Willis, Havemeyer Building, New York city; N. G. Spaulsing, Schodack Landing, N. Y.; August T. Gillinder, 2 Nassau St., New York city; G. Howard Davison, Millbrook, N. Y.; A. Beekman Cox, Cherry Valley; Joseph C. Willits, 49 Wall St., New York city; W. A. Sweet, Syracuse, N. Y.; Dean Sage, Albany, N. Y.; Geo. P. Sawyer, Buffalo, N. Y.; John Bogart, 71 Broadway, New York city; I. B. Potter, Potter Building, New York city; Staley N. Wood, Hinsdale, N. Y.; Worthington Whitehouse, Elmsford, Westchester Co., N. Y.; Howard Willetts, 303 Pearl St., New York city; J. Y. McClintock, Rochester, N. Y.; W. Pierpont White, Utica, N. Y.; Martin I. Schenck, Greenbush, N. Y.

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Special Legislative Committee on Good Roads, State of New York: Richard Higbie, Chairman, Babylon, N. Y.; Chas. F. Schoepflin, Gardenville, N. Y.; Eugene F. Vacheron, Ozone Park, N. Y.; Wm. W. Armstrong, Rochester, N. Y.; Henry Krenrich, Jeffersonville, N. Y.; M. F. Tobin, New York, N. Y.; Henry J. Staley, Carlisle, N. Y.; J. E. Overton, Oyster Bay, N. Y.

Special Committee on Good Roads, Nashville, Tenn.: Maj. C. A. Locke, M. Am. Soc. C. E.; Hunter MacDonald, M. Am. Soc. C. E., and W. H. Schuerman, Professor of Mathematics in Vanderbilt University; all of Nashville.

Indiana Highway Improvement Association, Indianapolis, Ind.: Pres., J. S. Mount, Shannondale, Ind.; Secy., L. B. Eubank, Indianapolis, Ind.

Missouri Road Improvement Association, Kidder, Mo.: Pres., T. O. Stanley, Sedalia, Mo.; Vice-Pres., W. C. Adams, Atherton, Mo.; Secy. and Treas., Levi K. Chubbuck, Kidder, Mo.

Good Roads Association, Cromwell, Conn.: Pres., Dr. W. B. Hallock; Secy., T. W. Beaumont; Treas., Walter Fewthrop; Executive Committee, W. S. Coe, John B. Bond, Geo. S. Butler, H. W. Congdon, and A. N. Pierson, all of Cromwell, Conn.

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Douglas County Road Improvement Association, Omaha, Neb.: Pres., Chas. F. Manderson, Vice-Presidents, Guy C. Barton and William A. Paxton; Treas., Ben. B. Wood; Secy., Curtis C. Turner; Victor B. Caldwell; all of Omaha, Neb.

Michigan League of Good Roads: W. L. Webber, Pres., Saginaw; William Appleton, Vice-Pres., Lansing; E. M. Hopkins, Secy. and Treas., Saginaw; John McVicar, Detroit; C. V. De Land, Jackson; Silas E. Woodworth, Plainfield; H. C. Weeks, Allegan; S. S. Bailey, Grand Rapids; Dallas J. Don, Flint; G. W. Howe, Port Huron; C. H. Peters, Saginaw; Wm. Carpenter, Muskegon; William Crosby, Harbor Springs; Reuben Goodrich, Traverse City; William Chandler, Sault Ste. Marie.

Mifflin County Good Roads Association, Milroy, Pa.: Pres., Chas. Bratton, Shanks Run, Pa.; Vice-Pres., J. H. Peachey, Belleville, Pa.; Secy., S. T. Moon, Milroy, Pa.

THE NEW YORK & BROOKLYN R. R. CO. has been granted the right by the New York Board of Aldermen to build a tunnel under Ann St., from Park Row to the East River. The company proposes a tunnel under the East River terminating in Brooklyn at Middagh and Furman Sts. The length would be 8,225 ft., and approach grades of 4% as a maximum are proposed. Mr. Benjamin F. Henning, who has been prominent as an advocate of a gravity tunnel on this site, is the principal promoter of the scheme, and among others interested are Alonzo B. Cornell, E. R. Hoadley and Irving Washburn, of New York. The company has agreed to pay the city 2½% of its gross receipts. It is designed to use electricity for the motive power; but the cars will run by gravity alone down each approach and a good part of the distance across the river.

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AND
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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The wisdom and zeal shown by Toronto, Ont., in making the most of her franchises for the use of the public streets might well be followed by many of the cities of the United States. In our issue of Nov. 7, 1895, we published some figures showing the revenue derived from street railway franchises in that city. The Board of Control of Toronto, of which Mr. R. J. Fleming is chairman, is now advertising for sealed proposals for the

PRIVILEGE of constructing and maintaining a telephone service for the citizens of Toronto, for a term of five years, or longer.

We have capitalized the word privilege in the above quotation. On this word hangs the whole idea of compensation to cities for valuable franchises, but most of our American cities do not appreciate the fact.

In our column of "Letters to the Editor" this week, a valued correspondent directs attention to the call for competitive designs for the bridge across Newtown Creek, Long Island, and condemns in strong terms the scheme which has been adopted for securing plans for the structure. We doubt not that he voices the sentiments of many of our readers, and we ourselves were inclined on first examination of the scheme to take a very similar view. As we read the advertisement referred to more carefully, however, and consider all the circumstances in connection with the case, we find ourselves obliged to examine the matter from the point of view of those who are in responsible charge of the work, and to ask candidly whether they have not adopted a wise course on the whole in thus opening to general competition the preparation of plans for this structure.

As a matter of fact, the question of the best design for this structure has been a subject of vigorous discussion for a long time. The crossing is one of considerable length, and the conditions of traffic are such that it is desirable to obstruct the channel as little as possible. The ordinary swing-span draw will not be permitted, we believe, by the army engineers. Of the substitutes which are available, at least three or four, and probably more, are covered by patents, and we know that some at least of these patented designs have been brought to the attention of the officials in charge of this work by their owners. Moreover, there is good reason to believe that some of these patented designs are exceedingly valuable for use upon just such sites as that of the Newtown Creek bridge. It would not be wise, therefore, for the Commissioners to employ an engineer to prepare plans for the work, with instructions to use no patented devices. Neither would it be well for them to employ him to decide between various patented designs, and others not covered by patents, without first finding what royalty the owners of these various patents would ask for their use. But this is practically what the competition which has been instituted is to determine, and this, we believe, is the reason why those submitting designs are asked to place a price upon them, instead of the more common course of naming a prize which will be given to the successful competitor.

In this connection a few words regarding the general conduct of competitions may be appropriate. The architects, who have had to deal with competitions ten times as much as have engineers, when they found that there was no stopping them, took the wise course of so controlling and guiding them as to secure the best results to those instituting them and those taking part in them. They formulated a system of general rules to govern architectural competitions, which has been of great value to the profession and to the public as well. One of the govering principles of this code of rules is that calls for competitions should require general designs and not details. The wisdom of this rule is easily seen. The preparation of general designs is a matter of moderate time and expense; but for detail designs a large outlay must be made. As a matter of fact the only ones who will undertake the expense of making detail designs for a competition, are the plodders of the profession who can find no more profitable occupation.

Now, as we read over the advertisement for plans for the Newtown Creek bridge, it appears to us that it conforms fairly well to this principle, as what it calls for are general designs and not detailed plans and specifications. Competitors are not even required to submit an estimate of the cost of carrying out their designs, nor specifications for use in their construction. In fact we do not see that anything is called for that is not really necessary to enable the relative merits of the competing designs to be fairly judged, nor is anything asked for that a bridge engineer could not furnish with a moderate outlay of time and expense, not out of proportion to his chances of success. Further, his compensation is not restricted to any fixed sum; but is set by himself; and if he be so ingenious and talented as to originate a design of very great merit, he is free to set a price upon it in proportion to his own estimate of its worth. This feature of the competition has the added merit, it appears to us, of guarding against the very thing which has so frequently proved an annoyance and source of complaint in competitions, viz.: the use without compensation of a design submitted in the competition. By inviting competitors to set a price upon their designs, the commissioners, it appears to us, formally acknowledge the ownership by each competitor of his designs. In the light of this acknowledgment, the use of the designs of any competitor without payment of the compensation fixed by him, at the commissioners' request, would apparently make them legally responsible to him, whether the designs were covered by patent or whether they were not.

The semi-circular shield used in constructing a large sewer in Paris, France, as described on another page, is deserving of attention as being, so far as we know, the first of all large shields of this form which has been made to work successfully. In 1892 a semi-circular shield, 30 ft. 8 ins. outside diameter, was put at work on the York Road tunnel of the Baltimore Belt R. R., but it failed on account of the settling of the crown and spreading of the haunches, and had to be abandoned. The cause of this failure was the light construction of the shield in proportion to its great diameter and the heavy load of unstable clay which it had to support. Indeed, the settlement began immediately upon the removal of the falseworks centering, and before the distorting effect of the hydraulic jacks in forcing the shield ahead through the clay had come into action. The French shield illustrated is only about 19 ft. in diameter, and is working in a sandy soil of considerable stability and with but a very small superincumbent load. Despite these favorable conditions of material and load, however, the successful operation of the shield is probably due largely to its heavy and rigid construction.

A second feature of this French work which will be of interest to engineers is the operation of the shield under a very small depth of earth—less than 2 ft.—without sinking or cracking the pavement above. Indeed, its success in this respect is remarkable, and gives much encouragement for the use of the shield system in tunneling under the streets of our large cities, where the demand for underground railways, sewers and subsurface conduits of all kinds is growing each year, and where the disturbance of the street surface means always heavy expense.

At the recent conventions of railway mechanical officers at Saratoga, resolutions were adopted by both the Car Builders and the Master Mechanics, protesting against the bill now pending before Congress by which the introduction of the metric system is made compulsory. These resolutions were adopted in both associations by a practically unanimous vote.

That this protest is fairly expressive of the sentiment of a large proportion of those engaged in mechanical engineering work, it would be idle to deny. It is true that many of the arguments brought forward against the metric system are as puerile as some of those presented in its favor; but there is one argument against the change whose weight it is difficult to exaggerate, and that is the expense involved in changing the present standard system of measurements. Take the one item of screw threads. The interchangeability of the present system of screw threads depends upon, first, a set of standard diameters, round iron or other metals, and second, a standard form, size and pitch for screw threads of the different systems. In almost every branch of manufacturing industry standards have been adopted for the bolts, nuts and screw threads principally used. We may mention for example the carriage industry, the standard threads for gas-pipe and fittings and the standard limit gages for round iron adopted by the M. C. B. associations. Besides screw threads, thousands of other standards of size have been adopted in the various industries and have become a most important part of the modern system of manufacturing. Would a change to the metric system mean a change in all these standards? Doubtless it would, for it would be idle to retain standards whose dimensions could not be exactly given in metric units. That many million dollars are now invested in standard gages, templates, rules, scales, etc., and in the machinery for their reproduction and use cannot be doubted; and this investment would, of course, be destroyed by a change in the system of measurements; but this, in fact, would be a trivial part of the cost of a change in the system of measurements. For a period of some 20 or 30 years it would be absolutely necessary to maintain both systems in use, or until every existing machine built according to present standards had gone out of use. Take the railway cars of the country, for example. At every repair shop it would be necessary to carry a duplicate stock of bolts, nuts, round-iron, screw-cutting tools, etc., one for cars built on the metric system, the other for cars built on the present system.

It will be evident without further illustration that the interests which would be so seriously affected by a change in our system of measurements will be heard from very forcibly, as soon as any probability appears of a compulsory adoption of the metric system.

For the other arguments against the metric system, it appears to us very little can be said. The argument that the foot or the yard are in-

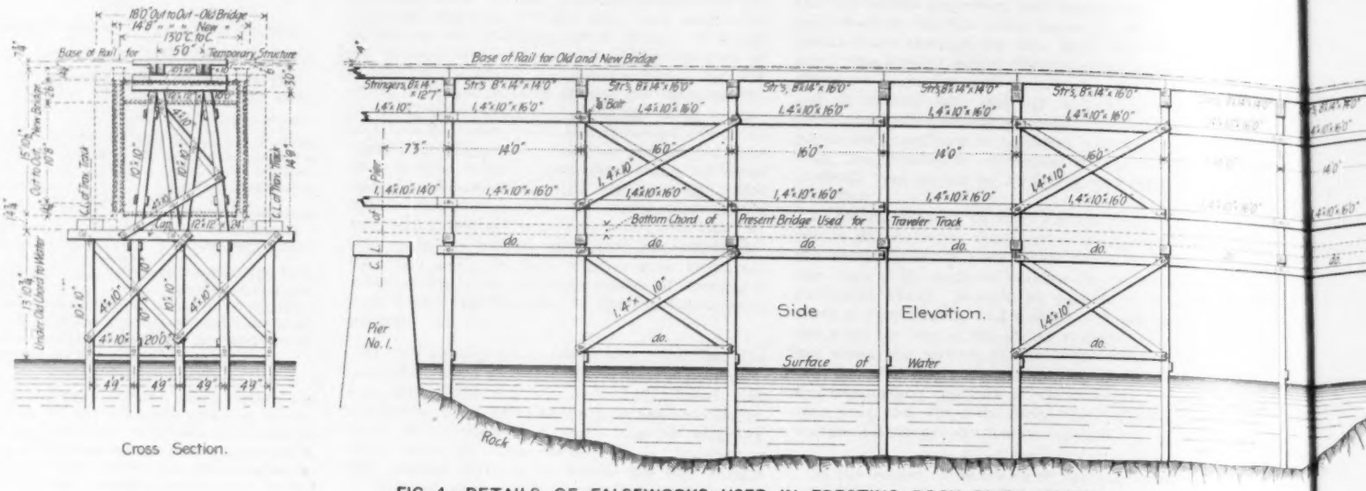

Base of Rail for Old and New Bridge
Side Elevation.
Surface of Water
Rock
Pier No. 1.
Bottom Chord of Present Bridge Used for Traveler Track
Cross Section.

FIG. 4.—DETAILS OF FALSEWORKS USED IN ERECTING ROCK RIVER BRIDGE.

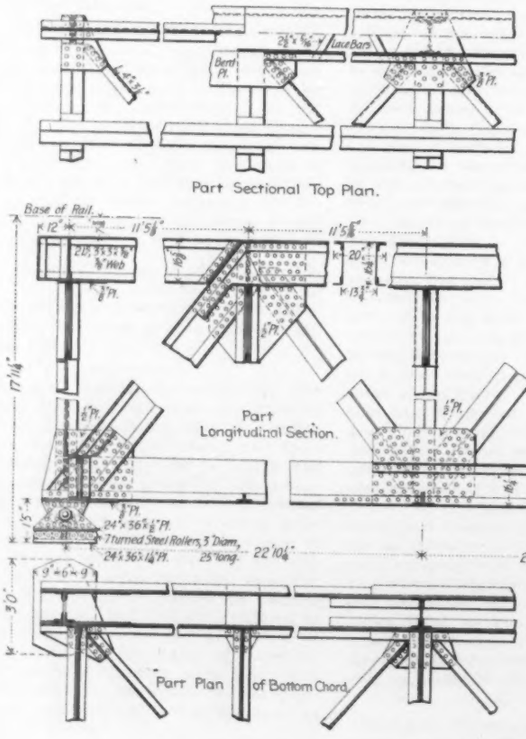
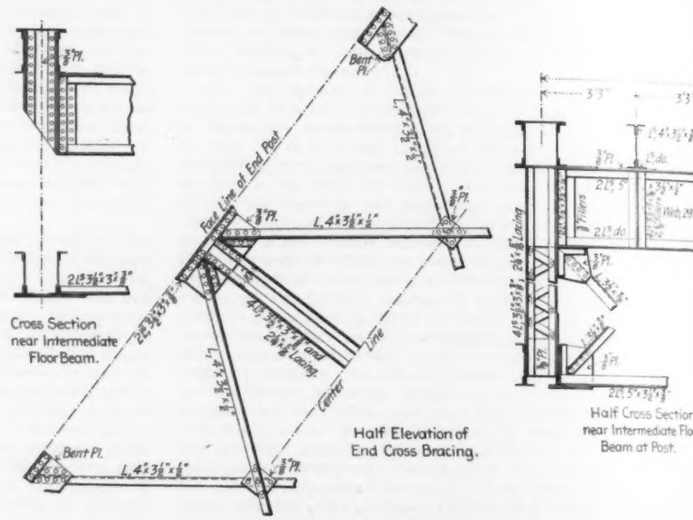


FIG. 3.—DETAILS OF RIVETED TRIANGULAR TRUSS FOR NEW ROCK RIVER BRIDGE.


Cross Section near Intermediate Floor Beam.
Half Elevation of End Cross Bracing.
Half Cross Section near Intermediate Floor Beam at Post.
Far Line of End Post
Center Line
Bent Pl.

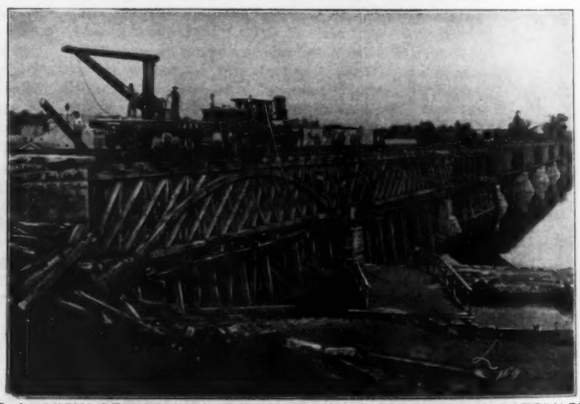


FIG 1.—VIEW OF ROCK RIVER BRIDGE, CHICAGO & NORTHWESTERN RY. DURING RECONSTRUCTION IN 1869.

(At the Near End of the Bridge are Shown the Burr Trusses Built in 1852, and at the Far End the Howe Truss Spans Being Erected in 1869.)

ROCK RIVER AND MERRIMAC BRIDGES,

J. E. Blunt, Chief Engineer. Wm. H. Finley, Bri

Wisconsin Bridge & Iron Co., Milwaukee, Wis., Contractors for Rock River Bridge.

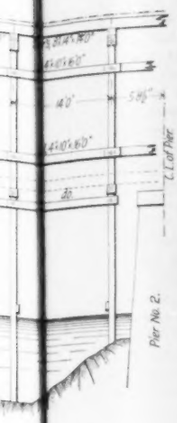


FIG. 8.—VIEW OF MERRIMAC RIVER BRIDGE SHOWING METHOD OF ERECTION.

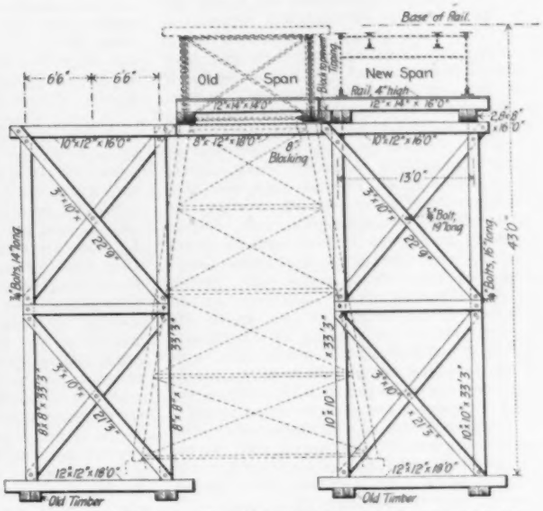
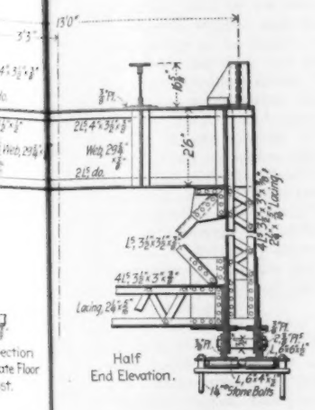
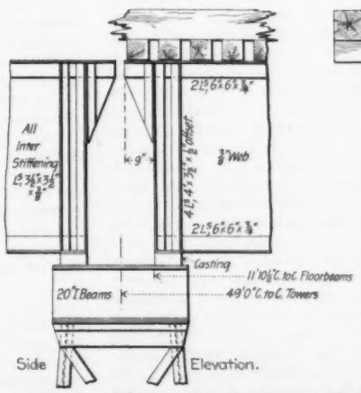


FIG. 7.—DETAILS OF FALSEWORKS USED TO ERECT MERRIMAC BRIDGE.





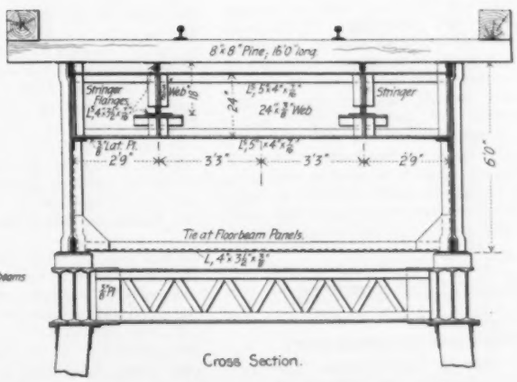


FIG. 6.—CROSS SECTION OF PLATE GIRDER SPANS SHOWING SUPPORTS ON TOWERS, MERRIMAC BRIDGE.

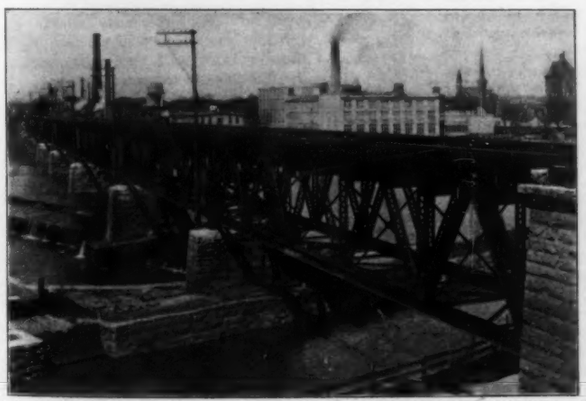


FIG. 2.—WROUGHT IRON BRIDGE AT ROCK RIVER, CHICAGO & NORTHWESTERN RY., BUILT IN 1895-6, TO REPLACE HOWE TRUSS BUILT IN 1869.

FIG. 5.—MERRIMAC BRIDGE, CHICAGO & NORTHWESTERN RY., SHOWING CHARACTER OF CONSTRUCTION AND METHOD OF ERECTION.

RIDGES, CHICAGO & NORTHWESTERN RY.

Finley, Bridge Engineer, Chicago & Northwestern Ry.

Lassig Bridge Works, Chicago, Ill., Contractors for Merrimac Bridge.

trinsically less convenient units than the meter or the centimeter is about as trivial as the claim that the meter is a better unit than the older ones because it is a ten-millionth part of the earth's quarter-circumference. The standard of length in either case is an artificial standard kept in a government depository. As for the claim that division of a unit by vulgar fractions is more convenient than decimal division, it may be said that if in certain industries this is really the case, then there is no reason why the metric units should not be divided by vulgar fractions.

Practically, however, there is little reason to believe that decimal divisions are inapplicable in machine shop work. In fact, the use of thousandths of an inch for accurate measurement is now universal in all well-managed machine shops.

It is claimed that drawings on the metric system are liable to error through misplacement of the decimal point; but it appears to us that this argument cannot be based on any familiarity with the system in use. An error which multiplies or divides the true quantity by ten is so large that it is sure to be discovered before it makes trouble. On the other hand, the metric figures being all of the same size are more easily written and more legible than the vulgar fractions of the present system. Take for instance the dimension $1\frac{19}{32}$". By the metric system this is written 0.036. We have one less figure to write, no small figures and no need for the inch marks.

Of the advantages of the metric system in computation, and in its simplification of the whole matter of weight and measures, it is not necessary for us to speak. They must be admitted by every one who has given the system careful and unprejudiced study. The question is whether all these advantages are worth the enormous sum which it would cost to make an entire revolution in our system of weights and measures. The people on whom the burden of cost of such a change would fall most heavily can be relied upon to answer this question in the negative; and as they are pretty certain to make a very strong showing on their side when the matter comes up for final action and to secure the ear of Congress, we are not likely to see the compulsory adoption of the metric system in this country at present.

The advocates of the metric system have frequently referred to the small amount of friction and expense that was caused by the change to the metric system in Continental Europe. It must be remembered, however, that when this change was made, manufacturing industry on the modern system was in its infancy. The system of standards, and the interdependence of manufactures was then almost unknown. The opponents of the metric system have good ground for asking, therefore, that the burden which the mere making of the change will impose upon the manufacturers of the country shall be carefully weighed before a change is compelled.

SAFETY IN LOCOMOTIVE BOILER CONSTRUCTION.

In our issue of June 18 we called attention to a published statement of the New York Railroad Commission to the effect that explosions of locomotive boilers of the radial stay type had been more violent than the explosions of similar boilers of the crown-bar type. As a result of our note the Master Mechanics' Association took up the matter at its recent meeting in Saratoga, and put itself on record as certifying to the safety of the radial stay type of boiler. No evidence was brought forward, in a discussion lasting more than an hour, tending to show that the radial stay boiler is not as safe in every respect as the crown-bar; and it was found that the New York Railroad Commission had based its recent remarks concerning radial stay boilers entirely upon experience with boilers of the Wooten pattern.

It is fortunate that the Master Mechanics' Association has taken this matter up and placed itself on record so promptly in support of the radial stay boiler as good and safe construction, else we might have had the New York Railroad Commission's deliverance on this subject quoted as authority in every boiler explosion case for years to come, and it might even have had a tendency toward keeping in use the crown-bar boiler on some roads which still cling to it.

But the discussion in the Master Mechanics' Association should be of value not only as an offset to the opinion rendered by the New York Railroad Commission. Many of the facts brought out in the discussion are not as generally known or not as generally realized as they should be, and some of these it is our purpose to note.

In the first place the essential feature of difference between the two types of boilers may be briefly explained. In the crown-bar boiler the downward pressure upon the roof or crown of the fire-box is carried by rows of crown-bars extending across the top of the fire-box from side to side and supported by the side sheets at the ends. A modern locomotive may have a crown-sheet area of 30 to 40 sq. ft., and with a steam pressure of 200 lbs. per sq. in. this means a total pressure of 86,000 to 115,000 lbs., tending to force the fire-box down and out of the boiler. In the crown-bar boiler this strain is resisted partly by the sling-stays which lead from the roof of the boiler to the crown-bars, partly by the stiffness of the stay-bolts which connect the side-sheets, and partly by the mud ring which connects the fire-box to the boiler proper at the base. What proportion of the total strain will be carried by each one of these three members is, of course, impossible to say; but neither the mud ring nor the side stays are designed to carry the strain which is brought up on them by the downward pressure on the crown-sheet.

In the radial stay boiler, on the other hand, the downward pressure on the crown-sheet is carried by stays which reach across to the roof of the outer shell, and thus the opposing pressure on these two surfaces are equalized.

An advantage of great importance in bringing the radial stay boiler into use is the greater facility with which it is cleaned. With modern boilers of high pressure the crown-bars and stays must be set so closely together that it is very difficult to clean the surface of the sheet. Under these circumstances the accumulation of scale on the sheet and consequent burning is more likely to occur. The obstruction to circulation due to the presence of the crown-bars is also an added objection to their use.

All these facts have long been known and as a result the past 30 years has seen a steady change in locomotive boiler practice. The crown-bar boiler, which was in practically universal use during the early decades of the railway era, has steadily been displaced until to-day probably 90% of all new locomotives are built with radial stay boilers. The experience related in the course of the discussion at the Master Mechanics' Association is good proof that this change has been a wise one. Many instances were given where locomotive boilers of the crown-bar type had exploded from low water, with the result that the fire-boxes were blown entirely out of the boiler. On the other hand, numerous cases were given of the failure of radial stay boilers from low water in which one or more rows of the stays merely pulled through the sheet, letting water and steam enough escape through the apertures thus formed to lower the pressure and put out the fire, and this with little or no injury to the engine, crew or the trains, and very little damage to the boiler.

It is impossible to reach any other conclusion from the testimony presented before the Master Mechanics' Association than that the radial stay boiler is safer than the crown-bar.

There are some features in the design of radial stay boilers to which attention was called in the course of the discussion that deserve especial emphasis. The first is the effect of making an arched or curved crown to the fire-box instead of a flat crown, the latter of course being always used with the crown-bar boilers. If low water occurs with a flat crown fire-box, the entire crown is overheated and softened until it comes down. If low water occurs with an arched fire-box crown, the central row of stay-bolts and a narrow portion of the sheet adjoining it is first heated. Ordinarily this causes the stay-bolts to pull through and this permits the steam and water to escape through the central row of stay-bolt holes, relieving the pressure and preventing an explosion.

But the pulling through of the bolts is more likely to occur if the stays are simply screwed in the sheet, like the side stays, than if they are given a buttonhead, like the stays used with crown-bars. Recent practice is tending toward the use of the buttonhead on radial stays and it is doubtful whether the change is an improvement. It was stated in the course of the discussion that when the Denver & Rio Grande R. R. was first opened, the locomotives had radial stay boilers, and notwithstanding the fact that the enginemen were a reckless set, and burned crown-sheets were common, an explosion was unknown. So confident did the men become that no serious mishap would follow an overheated crown sheet, that one man declared his intention of burning his engine on purpose; did it, and escaped without injury. At a later date the practice was introduced on that road of using buttonheads on the radial stays, and after that some explosions occurred. The safest construction for radial stay boilers, therefore, would appear to be to make the crown with considerable arch and make the central row or perhaps the central three rows of stay bolts without buttonheads. With this construction low water in the boiler should be reasonably certain to result in no serious damage.

The two most common causes of locomotive boiler explosions are broken stay bolts and low water. The former can be guarded against by a thorough system of inspection, in connection with the use of hollow stay bolts, which automatically give warning of breakage. It may be noted also that a crown supported by radial stays is less likely to come down in case of the forcing in of a side sheet than a crown supported by crown-bars, which has its support taken away if the side sheet fails.

The occurrence of low water can be guarded against to some extent by discipline, training and selection of enginemen, but with all care some accidents of this sort are bound to happen. It is, therefore, the duty of those entrusted with the design of boilers to adopt such precautions as shall insure against serious results from low water when it occurs. We have outlined above what the best practice at present appears to be. With this construction, supplemented perhaps by a proper system of fusible plugs in the crown-sheet, a railway officer in charge of motive power may feel reasonably safe against serious disasters due to low water in his locomotives.

LETTERS TO THE EDITOR.

Power Required to Move Balanced Valves.

Sir: Your issue of June 25, page 421, top of middle column, says that "the balanced valve requires on the average twice as much work to move it as the plain valve." Of course you will at once see that our report has been misquoted, as the converse was presented in the report, viz., the plain valve took about twice as much work as the balanced. We think this should be corrected. Very truly,

G. R. Henderson,
Chairman Committee on Slide Valves.

210 Ninth Ave., S. W., Roanoke, Va., July 1, 1896.

(We make the correction with pleasure. The error was so evident that it probably deceived no one.—Ed.)

Result of Employing an Incompetent City Engineer.

Sir: I have read with much interest the letter under the caption of "Know It All Engineer," in your issue of May 28. To further illustrate the "penny wise and pound foolish" policy pursued by many small municipalities in this state and elsewhere, I have only to cite a case which has come under my personal observation. A city not so far away has a population well on to 9,000 people; the city engineer is appointed for a term of years, at the handsome compensation of $50 per month; just think of it, $50 a month for a reliable civil engineer. This most worthy gentleman has caused to be placed on one of the principal thoroughfares a large quantity of broken stone called macadam, which would just about pass through a four-inch ring. This was dumped out and scattered upon the surface of the old street; the main street, at this writing, is "muddier," the mud and filth is deeper than in the old roads which lead up to the town. If I mistake not, $20,000 per annum is allowed by the city council for street improvements. As I understand the city does not even boast of a map, such a thing as a street profile is unknown, "hit or miss" is the motto. Any reputable engineer would be glad to accept one-fourth of the money now thrown away, as compensation. The day is not far distant when the "wise men" will be compelled to step down and out, and new brains and business ability take their places.

Until this is done many more dollars will be "ditched" and the salary of the city engineer remain at $600 per annum. Observer.

Charlottesville, Va.

The Competition for the Newtown Creek Bridge.

Sir: In your issue of July 2, I notice an advertisement from the joint committee of the city of Brooklyn and Queens county, N. Y., requesting bridge engineers to submit plans, strain sheets, etc., for a bridge to replace the present Vernon Ave. bridge. This advertisement is, by its terms and requirements, an insult to the engineering profession. It would seem that there should be engineers of ability in such work in and near Brooklyn from whom one could be selected whose reputation would assure satisfactory results, without trying to secure 15 or 20 separate designs from which some inexperienced man can construct a new bridge and thus benefit by the suggestions of those who have spent time and money in acquiring the necessary knowledge and practice for such work. It is different with contractors who compete for work. They do not spend days and weeks in elaborate calculations and careful work before submitting a proposition, but an engineer must make a complete study of his problem, must prepare elaborate plans and specifications, receive bids from contractors, in order to submit a correct figure for the estimate of cost, and must finally remember that all his work may be thrown away or used without compensation to him to assist a cheaper man to make a reputation. The only privilege that is accorded by this advertisement to a self-respecting engineer is to refrain from encouraging such proceedings by joining in the competition. Yours very truly,

James Ritchie, M. Am. Soc. C. E.

625 Hickox Building, Cleveland, O., July 4, 1896.

(We have commented on this matter in our editorial columns.—Ed.)

Securing Responsible Bidders on Contract Work.

Sir: You have frequently called attention to the fact that large amounts of money are saved to cities by advertising the letting of their contracts in your paper. This I do not deny, but I also affirm that you have done and are doing contractors a certain amount of harm, from the fact, not of the extensive advertising, but of calling together a lot of irresponsible, inexperienced bidders who slaughter prices and trust to luck or swindling to come out on their contracts. This could be remedied by suggestions to the numerous city officials with whom you come in contact that large deposits should be required to accompany bids, at least 10% of the bids, for instance. Take the city of Syracuse, N. Y., for example. At their letting in June, 1895, they required $6,000 on a bid in the neighborhood of $20,000, this to be retained till the completion of the work. The result was that they got responsible bidders and the work was finished satisfactorily. Take, on the other hand, Stony City, Ia. They require a check of $75, any foreman can bid, and trust to luck, either by selling out to the next highest bidder, or scamping on his work or beating his bondsmen to come out whole. I grant that the city will probably have to pay more when it requires a high deposit; but on the other hand the chances of litigation are less, and the chances for getting a decent job better. Might I suggest that as you have now educated municipalities up to the required point, that you now take our side of the question and see if you cannot give them a few ideas as to the desirability of having responsible contractors do their work, and that to attain this result, that they require a cash deposit amounting to at least 10% of the bid, and preferably 25%. Respectfully, Fred. W. Abbot,

M. Am. Soc. C. E., Assoc. M. I. C. E.

620 Chestnut St., St. Louis, Mo., May 26, 1896.

(Our correspondent's letter is an excellent presentation of the evils due to careless or incompetence in the drawing of contracts, and invitations to submit proposals, and we hope it may be carefully studied by every one of our readers who has responsibility or influence in connection with this work. We regret that the publicity given to contract letting by advertising in our columns, should, in some cases, draw irresponsible competitors to bid against reliable firms; but the remedy, as our correspondent says, is not by avoiding publicity in contract lettings but by adopting the usual well-known measures to ensure responsibility in the bidders.

The officials of almost every city of any size know very well that the cash or certified check as an evidence of good faith is an absolute necessity in inviting bids; but in many small towns this necessity is not understood. Moreover, it is not obscure people alone who are uninformed on this matter. It will be remembered that in the advertisements for the last government loan no deposit was required on the part of the bidders.

What percentage the amount of the deposit should be of the cost of the work, is a question which, it seems to us, ought properly to be considered separately in connection with each important piece of work. In works involving much doubt and difficulty, a higher percentage should be required than in the case of work whose cost can be accurately estimated in advance. Enough should be exacted in any case to ensure that only responsible and competent contractors will enter bids, for it is a waste of time to attempt to do business with men who are irresponsible and incompetent. But, on the other hand, no greater deposit should be asked of bidders than is necessary to ensure bona fide and desirable bids, for everything in excess of this interposes a needless burden on every contractor taking part in the competition, and one which may be especially annoying and vexatious where decision upon the proposals is postponed for some time.—Ed.)

Some Recent Tests of Louisville Cement.

Sir: The inspection and testing of cements as carried on for commercial purposes presents some entirely different features from similar work performed in a scientific laboratory or technical school, where experiments are made to determine the exact nature of different brands of cement with a view to establishing correct estimates to assist the practical engineer in drawing up specifications for such material. The conditions under which such work is done are as different as the ends attained. In the former case the inspector has to determine whether certain material furnished from the mills under ordinary running conditions comes up to requirements laid down by the engineer under whom he is acting, in the latter the scientist pursues investigations on isolated samples of the material the results of which, valuable as they are in themselves, are useless to the engineer as affording testimony of the value of the product turned out by the manufacturer in quantity at any particular time. In short, it is the province of the scientist to lay down rules for the guidance of engineers, and, what is more important, to establish a uniform system of testing applicable to all practical cases. Such can only be done by conducting experiments over a long period and under different conditions, and with all the different brands of material that come under the engineer's notice. The inspector is to be governed by such specifications in selecting the cement as are required by his clients. While such information, valuable to engineers and manufacturers alike, can be obtained by the work of the inspector, there is so little uniformity in the manner of testing as carried on by different men that no accepted standards can be selected from their discordant results and it is difficult to institute comparisons for this reason. In well organized laboratories for research, however, more uniform results can be obtained, as usually such experiments are carried on with care, and standard methods are employed in the testing.

Particularly noticeable is the absence of uniformity in the methods used in testing what are known as the natural cements. This is mainly due to the varying nature of the material, which allows the inspector more latitude in the selection of methods applicable to any particular case. Portland cement, on the other hand, is more uniform in quality and the testing can be conducted under conditions approaching more closely to standard methods. Portland cement, being the product of two ingredients, chalk and argillaceous clay, mixed in definite proportions, carefully selected and calcined with a degree of uniformity impossible with the natural rock, necessarily is more uniform in quality. The rock from which the natural cement is made varies so much quantitatively in the proportions of its ingredients that it is difficult to calcine it all to the same extent, for even the rock from the same quarry will show such wide variations in its composition that the resulting cement will vary widely in strength. It is therefore very important that we should have uniform methods of testing which will apply to the natural cements, and while much standardizing has been effected for the testing of Portland cement it seems to the writer that much of it is inapplicable to the systematic testing of the natural material. Unlike all other kinds of testing of materials for constructive purposes, in which tests taken under different conditions can be made comparable by deductions gathered from experience, or, as is more often the case, by mathematical analysis, the testing of cement depends so much on small details overlooked by some, and too much importance attached to them by others, that this kind of testing offers but little room at present for reducing results arrived at by different men to a common standard of comparison. For instance, from some tentatives pursued by the writer, the following details in the process of testing affect to a large degree the results, many of which are not considered in the reports of tests which from time to time are published:

1. The time the cement has been allowed to stand after being manufactured before gaging.

2. The manner of gaging, whether it has been accomplished by hand or machine.

3. The filling of the mold, whether the sample has been struck off on one or both sides.

A prolific cause for the rejection of natural cement is free or unslacked lime in the material which manifests its presence by checking the briquette, thereby reducing the effective area of the cross section and causing a reduction of the tensile strength. It is the opinion of many that in moderate amounts the CaO does not materially impair the value of the cement, especially if the cement be allowed to stand some time before using, thus giving the lime a chance to air slack. If the cement, hot from the buhrs, be gaged immediately, it would be rejected as incompetent if it showed the slightest signs of checking, while if allowed to stand it would pass inspection and be classed as good material. Thus much cement is rejected by the hasty inspector which would be passed by others. If the cement be used for plastering or work of that kind it is imperative that it shall contain no trace of uncombined lime. It is therefore quite important that the time elapsing between manufacture and gaging should be specifically stated in reports of tests. This will only apply to tests on neat briquettes, for unless the lime be present in very large quantities it will not show its presence in the usual manner in briquettes mixed up with sand. It is the writer's opinion that from this cause tests on natural cement made with sand briquettes are unreliable, for it is impossible to discriminate between inherent bad qualities in the cement and apparent lack of strength caused by the lime which in time would slack out and leave a reliable article.

Referring to No. 2. In laboratories where much testing is carried on, it is found necessary to use machines for mixing, as by the aid of such it is possible to perform four or five times as much work in a given time as could be accomplished by hand. The results, however, obtained are not the same. In the first place it is not easy to adjust the amount of water correctly for mixing with the machine, while with the hand sufficient can be added to bring the mass to the proper consistency. Even with different samples of the same cement the requisite amount necessary to enable the proper consistency to be reached will vary with the time the cement has been allowed to stand after manufacture. While the machine has the great advantage of rapidity, more accurate work can be done by the hand of an experienced person. The foregoing relates to tests made with neat samples, as machine made briquettes of sand and cement are entirely unsatisfactory, for the two components do not become thoroughly mixed in the machine on account of their difference in density. For commercial testing on a large scale machine mixers are almost a necessity, due to their increased rapidity, but for accurate scientific tests the spatula, handled by an experienced man, is by far the more reliable. In fact for comparative tests machine mixed samples are not at all trustworthy, and the element of the personal equation, incident to work performed by hand, introduces less variation into the results than the many defects of the different machines at present in use.

Referring to No. 3. The effect of this detail in testing is not as large as in the two preceding cases, but nevertheless it may give rise to errors which will seriously vitiate the results. The briquette made by striking off on one side only is decidedly inferior to that which has been turned and smoothed off on both sides.

In the first case the mold is laid on a glass plate or slab of some non-porous material, filled with the mixture by pressing with a former, smoothed over the top with a spatula and then allowed to set. Even with more than ordinary care the mold is often not completely filled by this method, as air bubbles will become caught at the bottom and further pressing will cause the air to enter the cement as there is no way by which it can escape. Thus one side of the briquette will be porous and a low tensile strength will be the result caused by eccentric loading on the specimen. By turning the briquette over, however, and applying the spatula to the other side, adding a little more cement if necessary to fill out the mold, a uniform density of cross section is ensured, which in some tests made by the writer made a difference of 3.7% on a series of samples. As these tests were made with more than ordinary care a larger discrepancy can be looked for under usual conditions of working. The following table gives the results of some tests made by the writer on several brands of Louisville cement during the past year:

No.	No. of tests.	Av'ge, lbs. per sq. in.	Remarks.
1.	4,997	121.7	24 hrs. in air and 6 days in water.
2.	210	120.0	24 hrs. in air and 5 days in water.
3.	40	124.1	24 hrs. in air and 4 days in water.
4.	58	118.0	24 hrs. in air and 3 days in water.
5.	113	116.7	24 hrs. in air and 2 days in water.
6.	840	117.2	24 hrs. in air and 6 days in water.
7.	3,471	68.2	½ hr. in air and 24 hrs. in water.
8.	271	72.0	½ hr. in air and 24 hrs. in water.

It will be seen from the table that the larger number of tests were made of seven days duration. The manner of testing employed for Nos. 1, 2, 3, 4, 5, 8, was as follows: Samples were taken from the mill as the cement was packed, one sample to every two barrels. This was continued throughout the whole year from time to time so that the resulting average is a fair criterion of the product throughout the year. The cement was allowed to stand 24 hours after manufacture before gaging. The

gaging was done by hand, and the briquettes were struck off on one side only, a pressure such that a man could apply directly being used to force the material into the mold. The form of mold used was that adopted by the Am. Soc. C. E., which was laid on a glass plate during the filling. The briquettes were placed in still water until broken, which was done on a hand machine.

A glance at numbers one and six shows that a higher result was obtained from hand made briquettes than from those made by machine, number one being the hand-made samples, and number six the machine made. While the number of tests is not the same, they were so well distributed that comparison is quite justifiable. The same can be seen in numbers seven and eight, the latter 271 tests, mixed by hand, showing a higher breaking strength than the 3,471 tests of number seven, which were machine mixed. Except for the different method of mixing, numbers six and seven were treated the same as all the others; 87% to 94% of the cement would pass through a sieve having 2,500 meshes to the sq. in.

Robert S. Ball.

Louisville, Ky., May 29, 1896.

Railway Yards and Terminals.

Sir: Your issue of June 18 contains a very interesting article on "Railway Yards and Terminals," by Mr. W. L. Derr. This subject is an important one and one that the text books on railway construction treat with extreme brevity.

The inadequacy of railway yards and terminals, for which Mr. Derr says the engineer is to some extent to blame, is due to a variety of causes. On all our older roads the volume of traffic has increased so many fold as to far exceed the most roseate imaginations of the original builders. Moreover, many projectors of railways are merely financiers or promoters, who can see only so many miles of main track from terminus to terminus, and fancy when they have constructed that much, with an occasional passing track, they have finished a railway. And in many cases the building of such a skeleton of a railway has exhausted all the available funds and the construction of suitable yards is a financial impossibility, even when their necessity is recognized. If the engineer of a single track railway 72 miles long should tell his employer that it would be necessary to build 48 miles of yard and side tracks, he would probably be considered an unsafe adviser, to say the least. But such a ratio of main track to sidings is not imaginary.

No typical plan will answer equally well for division points and terminal yards; the local conditions and the necessities of each case must be considered and a plan worked out to meet them as nearly as the limitations imposed will allow. A former chief used to say to me: "Go and see the division superintendents; find out what they are doing and how they do it; what they would like to do and how they would like to do it; then find out what must be done and the best way to do it; then make your yard plan."

The guiding principles laid down by Mr. Derr are well put. The capacity of any yard should not be gaged by the number of cars that can stand on its tracks, but by the number of cars that can be put through it in a given time. Yet, in a great many localities it becomes necessary to hold cars for various reasons, and the importance of providing sufficient "hold" tracks, so that the efficient working of the yard may not be interfered with, must not be overlooked. On an old established road the amount of space to be reserved for storage of "hold" cars can readily be estimated. The proper points for storage of empties should be well considered, and plenty of track room should be provided at the various points selected for this purpose. It often happens that the road has some long gravel pit tracks that can be utilized for storage of empties. Probably a large number of these empties can be profitably stored quite close to some large car shops, so that they might be put in thorough repair during the dull season and thus be ready to render efficient service when the rush season comes on. The empty car storage tracks on Mr. Derr's diagram are very long stub tracks, which are objectionable. As a rule, all yard tracks should have switches at both ends, and if in any case it appears necessary to use a one-ended track, such track should be no longer than sufficient to hold as many cars as the ordinary switching engine can readily handle. When a long stub-end track gets full of empties, the cars at the stub end are likely to remain for weeks and months, serving as bumping-posts, and no matter how long the track may be, there will always be a car run off the end of the track or broken on the bumping-post.

Mr. Derr's axiom that "all general movements of the traffic should be forward ones," has good sense behind it. Another principle, which he does not enunciate in words, but which he has indicated in his typical plan, is that at any division or terminal yard where the amount of traffic or switching (classification) is considerable, there should be two yards; that is, one for eastbound and one for westbound traffic. For instance, take a division terminal having one yard of twelve tracks, the yard may be overcrowded and the work delayed. Probably the congestion would be relieved if the same amount of track were properly arranged in two yards of six tracks each, rather than as one yard of twelve tracks. The movement of a "slow freight" over its division is expedited by having its train made up in station order. This can best be done by re-classification in a local order yard, subordinate to the classification yard, such as is indicated in the typical plan on page 396 in your issue of June 18. But if the yard has not proper facilities for such a re-classification, there will probably be a net gain in time and expenses if the trains are sent out as originally made up. Perfect classification in the rush season should not be attempted in a yard that was not designed for such work.

The "bad order" or "cripple" cars should have tracks especially provided for them, where repairs can be made promptly and economically. These tracks should be two-ended, so that cars can be taken out as soon as repaired without waiting for every car on the track to be repaired. The repair tracks should be located adjacent to the division storehouse and blacksmith shop. Some officers want to locate the repair tracks close to the reception or classification tracks, so that it may not be necessary to move a "cripple" but a short distance. But a bad order car that has been hauled five or 25 miles over the main line in a train, can be safely moved another half mile in a yard if necessary, and it is cheaper to move these cripples to the tracks near the storehouse by means of a switch engine than to have the car-repair crew spend their time "toting" heavy castings from the storehouse to distant repair tracks. It is customary to locate the storehouse and blacksmith shop adjacent to the round-house, and wherever it is best to locate these buildings, there should the repair tracks be.

It is said with good reason that the cars and their contents receive more damage in going through an ordinary yard than by passing over a division 200 miles long. The common method of "tail-end" switching, without having a rider on every cut, is responsible for a great deal of this damage to rolling stock and freight. Some object to poling and gravity yards because such a large number of men are required for riders, but there should be a rider for every cut, whether the tail-end or poling method is employed, and it will often be found a good business proposition to take some of the car repairers and put them on as riders. It is cheaper to employ men enough to avoid the necessity of repairing cars than to keep a large repair force and a heavy stock of car material at every yard. Again, the capacity of a locomotive in "drilling" cars can be increased or diminished according as the number of men employed with it is increased or diminished. In a properly planned yard, when a large increase of business occurs, instead of putting a second drill engine in service, the crew of riders should be doubled, and when business drops off again the same engine can still be kept busy, if the number of riders is decreased.

As noted by Mr. Derr, that very important car, the caboose, is also the source of considerable trouble in the yard. Each caboose has its particular crew. It is their temporary home; their storm clothes and dinner pails are in it. The conductor has there his desk, and the amount of clerical and literary work required of a conductor makes it necessary that he should have a desk or an office. The caboose is frequently the sleeping room of the train crew, hence as soon as possible after reaching the end of a division, the caboose should be set where it will not have to be disturbed until required for another train. The freight cars on arrival at a division point go forward in the same direction as they entered the yard. The locomotive and the caboose, after a rest of greater or less time, return from whence they came, and with the rule "first in first out," the oldest caboose should be at the front. The unique caboose track shown in Mr. Derr's diagram accomplishes the end in view very neatly. The cabooses are transferred from the eastbound to the westbound yard and arranged in order of their priority by one movement.

The scheme outlined in Mr. Derr's sketch has so many conveniences and good features that one really believes him when he says that it "does not represent any actual yard." I wonder if the plan has ever been drawn to scale. I have not attempted to do so, but I fancy it would require a piece of ground 2½ miles long and ¼ mile wide, to begin with. The sketch is an excellent arrangement, however; but railways do not as yet build their yards that way.

Mr. Derr says that the angle of the ladder track and the yard tracks should be the same as the frog angle. This view is held by many, but I do not consider it an axiom. On the contrary, there are advantages in using an angle greater than the frog angle. One is that a less length of land is required for the yard, and another is that the switches can be placed closer together. Where one switchman has to handle a dozen switches on one ladder track with a lively poling engine behind him, every foot of distance between the switches counts. If each switch is placed as close up to the preceding frog as possible, that establishes the minimum distance between switches, which is a function of the frog angle. Then the proper angle of the ladder track depends upon the distance between the parallel tracks and the distance between the switches on the ladder. As stated by Mr. Derr, the switching in a classification yard can be expedited by having switches operated from a tower by a simple set of levers without interlocking.

Mr. Derr describes a slip switch in a ladder track. There are some cases, where space is valuable, that slip switches are necessary and convenient. I have not found them necessary on a ladder track and would avoid their use wherever possible. They are hard to work and are the cause of many derailments and much profanity. The switchmen, with some reason, call them "puzzle switches." I would add to Mr. Derr's list of general principles the following: All yard switches should be point, or split, and not stub switches. Tracks in a classification yard should be not over 12 ft. c. to c., and repair tracks not less than 20 ft. c. to c.

In regard to switching passenger trains: At terminals all through trains have to be made up in reverse order after arrival and many of the cars have to be turned end for end. If a "Y," or balloon-shaped loop is provided it will prove a great convenience for such trains. Many of the "palace cars" are too long to be turned on the ordinary turntable.

The reason why so many badly arranged yards remain in service is often easy to guess. The superintendent may be alive to the fact that the work at a yard is unnecessarily expensive. The actual cost per day or per car is a matter of figures and can readily be demonstrated. A plan for reconstructing the yard may be prepared after careful study and the superintendent may feel confident that the reconstructed yard will enable him to make a great reduction in expenses. The cost of the proposed construction can be closely estimated, but it is not so easy to demonstrate by actual figures what the saving of expense will be, and the manager perhaps dreads the confusion which will reign during the period of reconstruction. The engineer who plans the rebuilding of a yard should use a bold hand and spare not. Such cases generally require radical treatment. The existing yards are generally the result of long-continued gradual growth of business and a persistent though short-sighted attempt to keep down expenses, as pointed out in the editorial on this subject in your issue of June 18.

It is unprofitable to attempt to operate a railway with old-fashioned light locomotives. It would be better to throw them away and buy new ones. The manufacturer whose shop is full of tools that were good 20 years ago will be distanced by his wide-awake competitor who buys the latest improved machinery. The railway company that continues to use old, badly planned or outgrown terminal yards will not be able to reduce its operating expenses to the figures shown by its more wide-awake competitor.

T. Appleton,
Great Northern Ry.

St. Paul, Minn., June 26, 1896.

Obtaining the True Meridian by an Observation of the Sun.

Sir: I was much pleased to learn by the letters in your issue of May 14 that the method of obtaining a true meridian by a single observation of the sun was coming into use again. The observation is so easily made, the reduction of the formulae so simple, and the result so accurate and precise, that it should be universally understood and generally used in all sections of the country, and, as it requires nothing to be added to an ordinary complete surveyor's transit, except a little piece of red glass it should become very popular. In order to popularize it, however, it should be put in such shape and so carefully explained that all surveyors can apply it readily and confidently as to the result. It is with that end in view that I beg to trespass on your space by giving some practical hints as to the requisites for and manner of making the observation, and the solution of the spherical triangle, and show the degree of precision obtainable with an ordinary engineer's and surveyor's transit with a vertical arc, or preferably a full vertical circle, reading to single minutes.

I shall not attempt any demonstration of the theory as that is fully explained in all books on surveying under the topic of the Solar Attachment. All that the surveyor needs to supply himself with, in adddition to his ordinary outfit, is: (1) A piece of red glass cut or broken to a size sufficient to place in the cap of the eyepiece of his instrument and cover the aperture, so that he may look directly at the sun. (2) A table of mean refractions. All the later books on surveying contain this table; but if his book doesn't, the following will supply his wants near enough for all practical purposes, and can be copied in his field book:

Altitude.	Refraction.
17°	3′
20°	2′30″
25°	2′
40°	1′
60°	0′30″

(3) A table of declinations of the sun.

All nautical instrument dealers keep the nautical almanac for sale at a cost of 25 cts. The tables of declinations, etc., in these books are copied directly from the American Ephemeris or Nautical almanac, published at Washington for each year, some years in advance, and are based on the meridian of Greenwich. The "World Almanac" for 1896, on p. 38, contains a table of declinations for every day in the year, based on the meridian of Washington. This is a very convenient table, as it is all on one page and can be cut out and pasted in the field book. The "World Almanac" costs 25 cts.

The "Farmers' Almanac" also contains it, calculated for the 75th meridian, and so does the "New England Almanac," calculated for the meridian of New London. These two cost 5 cts. each if they have to be purchased. This is all the surveyor needs in the way of equipment.*

He should know his latitude to the nearest minute and his longitude approximately; then he is prepared to take his observation.

The simplest formula that I have seen is the following:

$$\sin \tfrac{1}{2} A = \sqrt{\frac{\sin (S-L) \sin (S-h)}{\cos L \cos h}}$$

$$S = \frac{L + h + p}{2}$$

In which A = the azimuth of the sun, or its angle with the true meridian.

L = the latitude of the place of observation.

h = the altitude of the sun, or the vertical angle diminished by the refraction.

p = the sun's polar distance = 90° + the sun's declination when it is south, and 90° − the declination when it is north.

Being desirous of knowing how closely a meridian could be obtained by this method, I established a true meridian at Perth Amboy in the ordinary way, and made my observations from the south end of that.

The latitude of Perth Amboy, N. J., is 40°30' north, longitude, 74°16' west.

On Feb. 1, 1895, I took a series of three observations as follows:

1st. Time, 9 h. 40 min. a. m., vertical ang. 22°28', azm. 140°18'.

2d. Time, 9 h. 42 min. a. m., vertical ang., 22°48', azm. 140°50'.

3d. Time, 9 h. 44 min. a. m., vertical ang. 23°07', azm. 141°32'.

The three work out exactly.

As an illustration of the application of the formula I will work out the third.

The vertical angle reduced for refraction = 23°07'−2' = 23°05' = the sun's altitude at time of observation.

By the nautical almanac the sun's apparent declination for apparent noon at Greenwich on Feb. 1, 1895, was S. 17° 5' 1.3", which reduced to the longitude at Perth Amboy, or the 75° meridian, was the declination at 7 a. m., or 5 hours earlier; the difference for one hour was 42.76"; the time of observation, 9 h. 44 min. a. m., was 2¾ hours later than 7 a. m., making a difference of about 118", called 2 minutes. As the sun is coming north, and its declination decreasing, the 2 minutes is subtracted and the declination becomes S 517° 3'; p., the polar distance, is 90°+17°3' = 107°3'; then, by the formula:

L = 40° 30'
h = 23° 05'
p = 107° 03'

170° 38' ÷ 2 = 85° 19' = S

S − L = 85° 19' − 40° 30' = 44° 49', and S − h = 85° 19' − 23° 05' = 62° 14'.

Then the formula becomes:

$$\sin \tfrac{1}{2} A = \sqrt{\frac{\sin 44^\circ 49' \times \sin 62^\circ 14'}{\cos 40^\circ 30' \times \cos 23^\circ 05'}} =$$

sin 44° 49' = 9.848091
" 62° 14' = 9.946871
10 − cos 40° 30' = 0.118954
10 − cos 23° 05' = 0.036243

2) 19.950159

9.975079 = sin of ½ A

½ A = 70° 46'
A = 141° 32'

As that agrees exactly with the azimuth as read on the instrument, it shows that the degree of precision is all that can be desired. By reducing the vertical angles of 1 and 2 each by 2' for refraction and using the same declination they will each check out in the same manner. Here is another, taken when the declination is north: July 10, 1895, time 4 h. 8 min. p. m., vert. angle 36°, azm. 90° 20'. Vertical angle reduced for refraction = 36°−1' = 35° 59'. Declination as above for July 10, at 7 a. m. = 22° 15' 10.6". North, hourly change 18.93" × 9 hours = 170", call it 3'. As the sun is going south the declination becomes N 22° 12', and the polar distance 90° − 22° 12' = 67° 48'—this will work out all right.

For a time calculation the formula is

$$\sin \tfrac{1}{2} T = \sqrt{\frac{\sin A \sin Z}{\cos c \cos d}}$$

in which
T = Solar time.
A = Azimuth of the sun as determined by calculation.
Z = Sun's zenith distance = 90° − corrected altitude.
d = Sun's declination.

Using the example worked out above, we have A = 141°32"; Z = 90° − 23°05' = 66°55'; and d = 17°03'; then the formula becomes

$$\sin T = \frac{\sin 141^\circ 32' \times \sin 66^\circ 55'}{\cos 17^\circ 03'}$$

sin 141° 32" = 9.793832
" 66° 55' = 9.963757
10 − cos 17° 03 = 0.019520

sin T = 19.777109 ∴ T = 36°46'

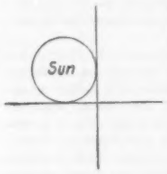
*In all these tables the declination is for noon of the given day.

in terms of angle from the meridian; 36°46' = 36.75° × 4 for one degree = 147 minutes of time = 2 hrs. 47 minutes before noon by the sun; 12 m. − 2 hrs. 47 mins. = 9 h. 33 min., solar time. Equation of time for Feb. 1, 1895 = 13 mins. 48.41 sec. slow, call it 14 minutes. Local time then for Perth Amboy, Long. 74° 16' W., at the moment of observation, was 9 h. 47 mins. a. m., corrected for standard time 75th Mer. = 9 h. 44 mins. a. m. = time noted.

Now as to the practical part of the business: The surveyor can carry the little piece of red glass in his pocket-book and have it with him all the time without inconvenience, so that he may be always prepared for an observation. If he has his tables of refraction and declination pasted in his note-book and a pocket-book of logarithms with him he can work it out then and there; or he need simply note the day and hour and the two angles and work it out when he requires it, at any time.

Suppose one is running out a large tract of land for the purpose of laying it out, etc.; he selects one of the lines running nearly north and south and from the south end he takes the altitude and azimuth of the sun. The difference between his observed and his calculated azimuth is the true bearing of his line, and he has all his lines referred to the true meridian, and that part of the field work can all be done in five minutes.

As to the manner of making the observation: It is better not to try to bisect the sun. The better way is this: Get the sun in the position shown in this diagram, in which the vertical and horizontal lines represent the cross wires of the telescope. If before noon, take the lower and receding, and if in the afternoon the lower and preceding limb, and then add 16' to each angle. The sun's diameter is 32'. This varies slightly, but not enough to affect the result for our purposes.



If an instrument with a vertical arc is used it is necessary that it should be in perfect adjustment as a level or the observer won't get his altitude correctly. By using an instrument with a vertical circle he can then eliminate all errors of adjustment by this method: First, take the lower and preceding limb of the sun and read the angles; then reverse the telescope and take the upper and following limbs, and read as before. The mean of the angles will be the true vertical angle and azimuth without reduction to a centre, and all errors of collimation will be corrected. This last was the method formerly used by Mr. Geo. H. Blakeley, C. E., of the Passaic Rolling Mills when he was engaged in surveying some 15 years ago, and to him I am indebted for it.

It is fully agreed that the best time for making an observation is when the sun is moving rapidly in altitude, never near noon, or when the sun is low in the horizon. For that reason the little table of refractions given above covers sufficient range. For that reason, also, a vertical or diagonal eye piece is not a necessity, as the observation can always be taken at a time when the observer can look at the sun directly without inconvenience.

In practice it is advisable to use a line of reference and turn from that. In that case, when the red glass is used, it will be necessary to set on the line, then unscrew the eye piece cap, put in the glass and turn on the sun; with the red glass in the eye piece one cannot see anything much less bright than the sun.

If it is desired to let the sun shine through the telescope and quarter its image on a card held back of the eye piece, as mentioned by Mr. McCullough and Mr. Guinn, in your issue of May 14, and get the sun's position in that way, it will be necessary to pull the eye piece out to its full length in order that the cross-hairs may be reflected on the card, otherwise they won't appear. I mention this because I believe the fact is not generally known.

The method is an excellent one but it requires two men to do it, while the direct observation requires the observer only.

I said I was glad that this method of getting the meridian was coming in again. It was used years ago and for some unaccountable reason fell into disuse. I have before me now a copy of "Gibson's Surveying," newly arranged, etc., by James Ryan, published in New York in 1821, wherein on pp. 355 to 357 full directions are given "to find the variation of the compass by an amplitude," with examples worked out, and in Jackson's "Military Surveying," I recollect there was such a formula, with examples.

In conclusion, I beg to state that this is written for the men who are not familiar with this method of getting a meridian, but who might use it if they understood its application. Should it meet the eye of any such and they choose to work out the observations, I would suggest that having worked them out as they are, that they change the altitude and then the latitude a minute or so and then make the calculation and note the result. By that means they will see with what degree of care these factors should be determined. Very truly yours, C. C. Hommann.

Perth Amboy, N. J., May 25, 1896.

THE PRICE OF GAS IN ST. LOUIS has been reduced by the Laclede and Carondelet companies to 80 cts., net, per 1,000 ft., for fuel, and $1,10 for illuminating gas, with 10% off for prompt payment in the latter case.

A HYDRAULIC SHIELD FOR SHALLOW TUNNELS.

A hydraulic shield, designed especially for tunneling under city streets at small depths beneath the surface has been in successful operation for some months in constructing a large outlet sewer in Paris, France, according to our French contemporary "Le Genie Civil." Besides its ability to work successfully with only from 1 to 2 ft. of earth above it, this shield is of interest on account of its semi-circular shape. The only other semi-circular shield of large dimensions which we now recall was the one tried on the York Road tunnel of the Baltimore Belt R. R. (Eng. News, Jan. 9, 1892), and, as will be recalled, it failed to withstand the pressure of the soft clay and had to be abandoned. The cause of this failure, and the reasons for the success of the shield illustrated, are discussed more at length in another column,

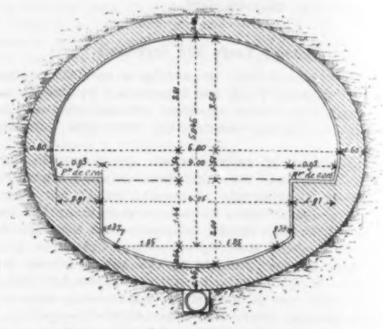


Fig. 1.—Cross Section of Paris Sewer Being Built by Hydraulic Shield System of Tunneling.

and here attention will be turned at once to the description of the Paris work.

A part of the sewer work for the city of Paris comprises the construction of an outlet sewer 4,462.35 m. (14,636½ ft.) long, extending from the Place de la Trinite to the banks of the River Seine. About 1,887.05 m. (6,189.52 ft.) of this sewer are outside of the city limits proper, and at a depth of only 0.4 m. or 0.5 m. (1.31 ft. or 1.96 ft.) below the level of the roadway of an important city streets, the Boulevard National. The cross section if this portion of the sewer is shown by Fig. 1. It was intended at first to build this part of the sewer in open trench, but the great obstruction which such an opening would cause to the street traffic, coupled with a guarantee of M. Chagnaud to do the work by tunneling without any such interruption determined the engineers to change their original plans.

In brief M. Chagnaud proposed to use a shield of special design to suit the conditions which required the construction of a masonry lining, and the safe support of a roadway carrying a heavy vehicle traffic and a double track street railway, operated by Serpollet motors weighing 16 tonnes (35,264 lbs.) each. Ordinarily where shields have been used the lining of the tunnel has been of cast-iron segments, which, as soon as erected, would withstand the thrust of the hydraulic jacks used in driving the shield forward. Green masonry could not be subjected safely to such a thrust and especial provisions had to be made for taking the pressure of the jacks. In this respect and in its provisions for supporting the heavy overhead load the shield used was peculiar.

Figs. 2 and 3 are cross and longitudinal sections showing the construction of the shield. Two elliptical arch girders B B rest on two longitudinal girders C C, and carry an exterior covering or lagging of steel plates 28 mm. (11 ins.) thick. The rear of this lagging terminates in a vertical plane, but the front is visor shaped. Its length at the longest part is 5.25 m. (17.24ft.), of which the visor makes 2.1 m. (6.88 ft.). The longitudinal girders C C rest on two trains of iron rollers K K, and also act as a support and track for a third arch girder D, which is independent of the shield proper, and can be moved back and forward inside of it.

To the arches B B are attached six hydraulic

jacks E E, each 0.24 m. (0.787 ft.) interior diameter, which are fed by a battery of four pumps P operated by a small electric motor V, and are double acting. Any one or all of these jacks may be operated at will. At N is the water supply and at S is a sill covered with a 1-m. (03937 in.) steel plate and forming a track for the rollers K K. Altogether the shield weighs about 50 tonnes (110,200 lbs.).

The method of operation is as follows: Steel frames G G, braced together by the I-beams H, are used to support the centers for the masonry arch during construction and also the temporary blocks for the lagging b. Altogether there are 37 of these used, spaced 1 m. (3.28 ft.) apart, and as the work progresses the rearmost frame is regularly transferred to the front and put into use again. The weight of the masonry on these frames—all being braced together—is enough to render the foremost frame firm against the pressure of the jacks, which thrust against it to drive the shield ahead. By this arrangement no thrust comes against the face of the masonry.

From Fig. 3 it will be seen that the piston rod passes through the girder D, to which it is attached, and abuts against the frame G. As the piston rod is thrust out, the whole shield, with the exception of the arch D, advances and cuts into the sand which the muckers dig out and throw back upon the continuous belt conveyor m m. As the shield advances, the wedges O O are continuously driven so as to make the lagging take up the space left by the skin of the shield which slips from above it. It will be noticed that the forward end of this lagging is carried by the arch D, which does not move during the advance of the shield proper. The shield having been pushed ahead 1 m. (3.28 ft.), which is the stroke of the piston, the stroke is then reversed and this brings the arch D forward into position for a new center G and new lagging. At the same time new wedges are placed over the center G and everything is ready for another advance of the shield.

This reciprocating motion of the shield proper and the inside arch D is the essential feature, as it permits the lagging to be held steady while the skin slips from above it and leaves no void except the thickness of the steel plate which is taken up by driving the wedges O O. Practically no settling of the superincumbent earth is possible if the shield and centering resist distortion.

As stated above the shield weighs about 50 tonnes. Except when loaded vehicles are passing the superincumbent load is small. No very great load thus comes upon the sills S S; indeed it is estimated that this load is only 0.4 kg. per sq. cm. The pressure of the hydraulic jacks is ordinarily 50 atmospheres, but when hard places are met it sometimes amounts to 100 atmospheres. The jacks have a capacity of twice this last pressure. In the sandy earth in which the work is being done the shield can be driven ahead 1 m. (3.28 ft.) in about 15 minutes. The daily advance of the completed tunnel is 7 or 8 m. (22.96 ft. or 26.24 ft.).

The masonry lining is carried on at a little distance in rear of the shield. Centers for the roof arch are placed two at a time upon the metal frames G G, and the upper part of the lining built. The lower half of the sewer is then excavated and the lining built to connect with the completed roof arch. About 900 m. (2.952 ft.) of the sewer had been completed at the time of the publication of the article by "Le Genie Civil," April 25.

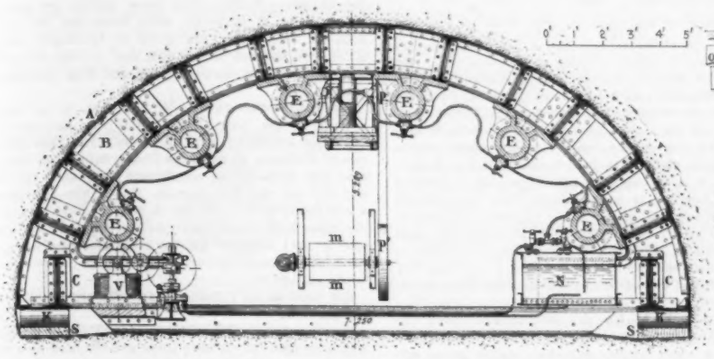


FIG. 2.—CROSS SECTION OF SEMICIRCULAR SHIELD FOR SOFT GROUND TUNNELING.

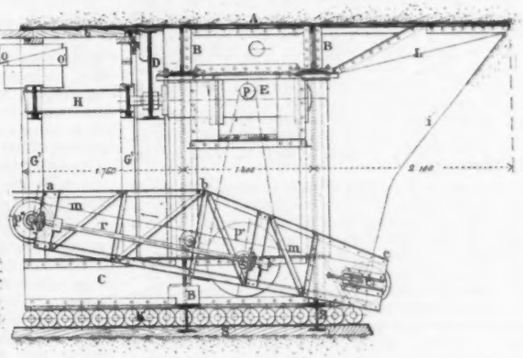


FIG. 3.—LONGITUDINAL SECTION OF SEMICIRCULAR SHIELD FOR SOFT GROUND TUNNELING.

METHODS IN USE FOR THE ANALYSIS OF ORES, PIG IRON AND STEEL BY THE CARNEGIE STEEL CO.

The Chemical Section of the Engineers' Society of Western Pennsylvania recently issued a circular asking for the co-operation of chemists in an effort to collect for publication the methods in general use for the analysis of ores, pig iron and steel. The reports of methods are to be published separately. The first report, now published by the society, is by Mr. John S. Unger, and it describes the methods in use in the laboratory of the Carnegie Steel Co., at Homestead, Pa. As the analysis of iron, steel, etc., is of considerable interest to a large number of our readers, we reprint Mr. Unger's paper in full, as follows:

Determination of Silica in Ores of Iron and Manganese.

To 1 gram of the ground ore in an 8 oz. beaker add 35cc. of HCl (1.20 sp. gr.), cover with a watch glass, and boil gently on a hot plate for 20 minutes. Remove and rinse watch glass and sides of beaker with 15cc. of water, filter off insoluble matter on an 11cm. filter, catching filtrate in an 8 oz. beaker, wash with water until all soluble matter is removed. The filtrate, which should not exceed 90cc., is placed on a sand bath and allowed to go to dryness. The filter is ignited and residue fused with 8 grams of carbonate of soda. The fusion is run up around the sides of the crucible and then the crucible is cooled by dipping cautiously in an 8 oz. beaker containing 35cc. water, finally turning the crucible on its side and leaving it. Cover beaker with a watch glass and add HCl gradually until effervescence ceases. After the fusion dissolves out of the crucible, remove with a glass rod and wash the crucible with water. The solution should not exceed 90cc. Evaporate on sand bath to dryness. When both solutions are evaporated, moisten the residues with 10cc. HCl (sp. gr. 1.20) and leave on bath for a few minutes; then add 20cc. hot water, and filter the first through an 11cm. filter, into a 16 oz. Erlenmyer flask, washing out beaker carefully, then filter the second through the same filter. If the alkaline salts have not all dissolved in the second add 20cc. hot water and stir until dissolved, filter and rinse the beaker with hot water wash, until filter is perfectly free from soluble salts. Ignite the filter in a muffle, cool and weigh as pure silica. The filtrate, which is preserved for further use, should not exceed 150cc.

Determination of Iron in Iron Ores.

To the filtrate from silica (given under silica) add 12 grams of B and A shot zinc and 10cc. conc. HCl and place in neck of flask a small funnel. Let the flask stand for about 20 or 30 minutes or until the iron is all reduced. Should the action on the zinc become feeble add 10cc. conc. HCl. When the iron is reduced test a drop of the solution with a drop of potassium sulphocyanide on a white porcelain plate. If it shows no color or just a very faint pink it is ready for titration. Have ready a 16 oz. wide beaker, a platinum triangle large enough to extend over the edges of the beaker, and a Gooch crucible with a tuft of glass wool ¼ in. thick at the bottom. Rinse the funnel into the flask with a wash bottle and pour the solution through the Gooch crucible, receiving the solution in the beaker. Rinse out flask three times with about 10 or 15cc. of water and wash the Gooch crucible once. To the filtrate in the beaker add 5cc. conc. HCl and place on a hot plate for 2 minutes. The solution will now occupy 225cc. Remove from the heat and titrate with standard bichromate solution, using 3 drops for each test toward the end, and adding the bichromate solution, 5 drops at a time, when almost done. Agitate each test drop by blowing gently and continue the addition of the bichromate until the last test shows an absence of blue precipitate after agitating and standing 30 seconds. The bichromate used, multiplied by the factor, gives the metallic iron.

The potassium sulphocyanide solution is made by dissolving 10 grams of the salt in 100cc. H_2O and is kept in a small bottle provided with a glass cap and a short piece of ⅛ in. glass tubing to be used as a pipette in taking out the test drops. The potassium ferricyanide solution is made by dissolving 0.1 gram of the salt in 100cc. water and test drops are removed as with sulphocyanide. The solution must be made up each day. One drop is used for a test.

The potassium bychromate is made by dissolving 52 grams in 12 litres of water, then shaking well and keeping the stock bottle protected from light.

The porcelain plate is 6 × 6 ins., with 12 depressions 1 in. wide by ¼ in. deep on its surface.

The bichromate solution is standardized by dissolving 3 portions of about 0.3 grams, 0.5 grams and 0.7 grams of perfectly clean soft iron wire of 99.80% pure iron in a 16-oz. Erlenmyer flask (having a small funnel in the neck), in 40cc. dilute HCl by the aid of gentle heat. When dissolved rinse the funnel and sides of flask and make solution up to 150cc. Add 12 grams of zinc and when the iron is reduced, titrate exactly as in case of iron in ore. The weight of the wire taken, multiplied by 0.998 and divided by the number of cc. of bichromate solution used, gives the factor and these factors should agree to the third decimal place.

For iron in manganese ores, the basic acetate precipitate of iron spoken of under manganese is dissolved in 40cc. dilute HCl, the solution made up to 150cc. and treated exactly as in the case of the determination of iron in iron ores.

Determination of Phosphorus in Steel, Pig Iron and Ores.

Dissolve 1.63 grams of steel in a 6 oz. Erlenmyer flask in 30cc. HNO_3 (sp. gr. 1.20). Place the flask over a burner and evaporate over naked flame to 15cc., add to the boiling solution 20cc. chromic acid solution, and again evaporate to 18cc., remove from fire and wash down sides of flask with from 5 to 7cc. H_2O and cool to 40° or 45° centigrade. Add 60cc. molybdate solution, previously filtered and heated to 40° or 45° centigrade, insert a stopper in flask, and shake for 5 minutes. Leave stand in warm place for 15 minutes, then filter through a 7cm. B and A, A grade) filter (previously dried and weighed at 110° centigrade), and wash with a 2% nitric acid solution until free from iron, then twice with 95% alcohol. Dry 20 minutes at 110° centigrade and weigh. Each milligram corresponds to .001 phosphorus.

For pig iron dissolve 1.63 grams, in a 4½-in. evaporating dish, in 40cc. HNO_3 (sp. gr. 1.20), evaporate to dryness on a sand bath. Then place on a burner and heat over naked flame until the mass ceases to evolve red fumes, allow dish to cool and add 25cc. HCl (1.20 sp. gr.), cover with a watch glass and evaporate to 10cc. Add cautiously 25cc. HNO_3 sp. gr. 1.42) and evaporate to 12cc., re-

move from burner, rinse watch glass and sides of dish, with 12cc. H_2O, filter through an 11cm. filter into a 6 oz. flask and wash with H_2O. The solution should not exceed 50cc. Heat to 40° centigrade, add 60cc. molybdate solution previously filtered, and heated to 40° or 45° centigrade,, shake and finish as for steel.

For manganese ores dissolve 1.63 grams in 40cc. HCl (1.20 sp. gr.) in a 4½-in. evaporating dish, by gentle boiling, then evaporate to dryness on sand bath, add 25cc. HNO_3 (sp. gr. 1.42) and evaporate to 12cc., dilute with 12cc. H_2O and filter through an 11cm. filter into a 6 oz. flask. The solution should not exceed 50cc. Heat to 40° or 45° centigrade, precipitate and finish as in case of steel.

For iron ores if no phosphorus exists in the insoluble residue and the ore is easily decomposed, proceed exactly as for manganese ore. Should phosphorus exist in the insoluble residue, dissolve 1.63 grams in 40cc. HCl (1.20 sp. gr.) in an 8 oz. beaker by gentle boiling for 20 minutes, dilute with 20cc. H_2O and filter into an 8 oz. beaker, washing with H_2O, set filtrate on sand bath and leave evaporate to dryness. Ignite residue and then fuse with 8 grams of Na_2CO_3 and dissolve fusion as for iron in ore, evaporate the solution to dryness on a sand bath, add to each beaker 25cc. HNO_3 (1.42 sp. gr.), and evaporate carefully to 12cc., dilute with 12cc. H_2O and filter both through an 11cm. filter into an 8 oz. flask, using the same filter for both solutions. Wash with H_2O, heat to 40° or 45° centigrade and proceed as for steel.

The chromic acid solution is made by dissolving 30 grams of pure chromic acid in 2 litres of HNO_3 (1.42 sp. gr.), at a gentle heat. It must be made up fresh at least every two weeks.

The molybdic acid solution is made by mixing 100 grams MoO_3 to a paste with 265cc. H_2O, then adding 155cc. NH_4OH (.90 sp. gr.) and stirring until all is dissolved. To this solution add 66cc. HNO_3 (1.42 sp. gr.) stir and set aside for an hour. In another vessel make a mixture of 395cc. HNO_3 (1.42 sp. gr.) and 1100cc. H_2O. Then pour the first solution into the second in a small stream, stirring constantly. Let stand for 24 hours when it is ready for use.

The filter papers for weighing the yellow precipitate are B and A 7cm. "A" grade. These retain the precipitate without it showing a tendency to pass through, and do not contain an appreciable amount of soluble matter, which might be extracted by the acid solution.

The stand for the evaporation over the burners is made of 1 in. angle iron bent and fitted with ¼ inch asbestos mill board, having a 2¼ inch hole over each burner; this supports the flask easily and prevents the solution from baking on the sides.

The drying bath is a copper drum with a coil of 1 in. steam pipe at bottom and fitted with a movable disk, near the top having ½-in. holes, through which the stem of the funnel is inserted, the whole being covered by a lid. Steam is supplied at boiler pressure and a temperature of 110° centigrade with very little fluctuation is constantly maintained.

Determination of Manganese in Manganese Ores.

To the filtrate from silica previously spoken of, add NH_4OH. When almost neutral, add it drop by drop until the solution assumes a redish brown color. When the last drop produces a redish brown precipitate, which does not dissolve on shaking, add 10 to 15cc. of ammonium acetate and bring to a boil. Boil one minute. Then remove and let the precipitate settle, filter through a 12½cm. filter, catching the filtrate in a 16 oz. beaker, wash out flask once with hot water. When the filter has run dry, place the funnel in the flask, and dissolve precipitate in 15cc. dilute HCl (1 to 1), wash iron out of paper and repeat the precipitation with ammonia and ammonium acetate, combining the filtrates. Wash the precipitate 3 times with hot water and reserve for the estimation of iron. To the filtrate add 3 drops of solution of phenolphthalein, then ammonia until pink, then 3cc. in excess. Pass a current of H_2S through the solution for 10 minutes, rinse delivery tube and set beaker on sand or steam bath for 30 minutes, filter through a double-pointed 7 and 11cm. filter, and wash with dilute NH_4HS water. When washed place a clean 12 oz. beaker under funnel and pour over precipitate 40cc. of a mixture of 20cc. hot water and 20cc. of 50% acetic acid, keeping the funnel covered with a watch glass. If the manganese sulphide does not all dissolve, pour the solution through the filter again, wash filter 4 times with hot water, and place beaker on a hot plate. Boil for 15 minutes, dilute to 150cc.; add 15cc. ammonium phosphate, and if a precipitate forms, add a few cc. of HCl until dissolved, bring to a boil and then precipitate by adding NH_4OH, drop by drop until the solution smells of NH_4OH. While precipitating stir constantly to bring the precipitate down in a granular form, filter through a 12½ cm. filter, using suction, ignite in muffle and weigh as $Mn_2P_2O_7$.

The ammonium acetate solution is made by dissolving 120 grams. in 2000cc. water, then filtering.

The ammonium phosphate is a saturated solution of the salt in cold water, diluted with an equal bulk of water.

Determination of Silicon in Pig Iron.

Weigh into a 4½-in. evaporating dish .9333 grams of sample, cover with a watch glass, then add 50cc. of a mixture of 10cc. H_2SO_4, sp. gr. 1.83, and 40cc. H_2O. Place over a Bunsen burner, supporting the dish on a piece of ¼-in. asbestos board, having a 2¼-in. hole in the center, and evaporate until dense, white fumes escape, and the drop of water which condenses on the watch glass falls back into the dish with a hissing sound. Remove dish from fire and let cool for two or three minutes. Then cautiously add 50cc. of a mixture of 10cc. HCl, sp. gr. 1.20, and 40cc. H_2O, place over burner and bring to a boil. Boil gently for one minute, remove from the fire, rinse the watch glass and filter the solution through an 11cm. filter. Wash once with water, then with dilute HCl (1 to 1) and finally with water until free from iron.

Ignite the precipitate in the muffle, cool and weigh. To the residue in the crucible add from 4 to 10 drops pure HFl, depending on the amount of silica present. Drive off excess of acid by heating gently on a hot iron plate, then ignite for two or three minutes in muffle, cool and weigh.

The difference in weight is divided by 2, and a decimal point inserted two places from the right hand gives the percentage of silicon in sample.

Determination of Sulphur in Pig Iron and Steel.

Weigh 5 grams of the sample into a 16-oz. side-necked flask, fitted with a rubber stopper and thistle tube. An 8-oz. beaker of the tall, narrow shape, containing 15cc. of cadmium solution and filled to within 1 in. from top with water, is placed under the delivery tube. Then 90cc. of a mixture of 40cc. HCl, sp. gr. 1.20, and 50cc. H_2O is poured into the thistle tube and the apparatus is placed on a stand made of ¼-in. asbestos mill board, having a 2¼ in. hole at one side and heated by a Bunsen burner. The heating is so regulated that the evolved gases are delivered at about three bubbles per second. As the action grows feeble, the heat is increased, until finally when all is dissolved, the solution is brought to a boil and kept boiling for one minute. The delivery tube is then raised out of the beaker and the flask is set aside.

The contents of the beaker are then poured into a 12-oz. wide beaker, the precipitate is washed out of the beaker with a wash bottle, and 5cc. starch paste are added. 35cc. of a mixture of 40cc. HCl. (sp. gr. 1.20) and 50cc. H_2O are then poured into the absorption beaker and rinsed into the solution in the large beaker. The sulphur is then immediately titrated with standard iodine solution.

The iodine solution is made by dissolving 8 grams iodine and 30 grams potassium iodide in 200cc. cold water and then diluting to about 1850cc. A standard steel is then tested by the method and the result noted, and from this the amount of water needed to dilute the iodine, so as to bring it to the required strength is calculated. After diluting, two determinations are made on the standard steel to see that the iodine solution is exactly right. The iodine solution is made of such strength that 1cc. = .01% of sulphur in the sample. Two litres of standard iodine are made up at once and the solution is preserved in a dark cupboard. The amount actually in use is kept in a special burette having a blackened receiver to exclude light. The stock solution is standardized every week.

The cadmium solution is made by dissolving 300 grams cadmium chloride in 1000cc. hot water in a large bottle and then adding 1500cc. NH_4OH (sp. gr. .90), filtering through a pleated filter into a 12 litre bottle. 6500cc. NH_4OH (sp. gr. .90) are then added to the solution and 3000cc. H_2O. The whole is well shaken when it is ready for use.

The starch paste is made by heating 1000cc. water to boiling point in a 1200cc. flask and adding gradually 10 grams of starch made into a cream with 50cc. cold water. Keep the solution boiling constantly. When all the starch is added boil five minutes, then set aside to cool, decant the liquid, throwing the last 50cc. away.

The solution is made up every three days.

Determination of Carbon in Steel.

One to five grams of the sample are weighed into a clean 8 oz. flask and 200cc. of copper potassium chloride are added, the flask is closed with a rubber stopper and shaken until the precipitated copper is completely redissolved, which is easily detected by the absence of copper covered particles at the bottom of the flask. Remove and rinse the stopper, then filter through a perforated platinum boat, having a layer of asbestos ⅛ in. thick at bottom and held in a platinum holder. Wash the residue twice with concentrated HCl, then with water until all the soluble matter has been removed. Dry the boat for two hours at 90° C., when it is ready for burning. Introduce into the combustion tube, pushing it against the roll of silver foil, start a current of oxygen from the cylinder through the apparatus at 2 to 3 bubbles per second. In the meantime weigh the potash bulb and the small calcium chloride tube filled with solid KOH. Attach the bulb and tube to the apparatus and light first two burners and leave burning for 5 minutes to heat platinum gauze in combustion tube to redness, then light the next burner and leave burning 2 minutes, following this by the others in exactly the same way. When all are lighted leave burning 5 minutes. Then shut off the oxygen and start the air current, being careful to make the change without allowing any back pressure from the air in the room. Aspirate air for 40 minutes, using 1000cc., and weigh.

The copper potassium chloride solution is made by saturating 2 liters of cold water with the salt, adding to the solution 100cc. of HCl (sp. gr. 1.20), then 1 gram of a high carbon steel, shaking until dissolved, then filtering the whole solution into a 2 liter bottle, through an asbestos filter.

The asbestos is prepared by rubbing the ignited fiber through a 20-mesh sieve, aided by a gentle stream of water, receiving the water and pulp in a large vessel, allowing the pulp to settle and drawing the water off by a siphon. Cover the pulp with strong, hot HCl, and digest over night, draw off the acid with a siphon and wash with water by decantation until free from acid, pour into a bottle with water sufficient to cover it, and when needed shake the bottle before drawing out a portion.

The purifying of the air and oxygen is effected in an apparatus having one side fitted to the aspirator bottles supplying the air, while the other side connects directly with the oxygen cylinder. The wash bottles are glass stoppered, filled to ½ height with KOH (sp. gr. 1.30), the attached $CaCl_2$ jars are filled to ⅓ height with solid KOH, the balance with $CaCl_2$ and a plug of glass wool on top; a Y tube connects each side with the combustion tube.

The combustion tube is of platinum, ¾ in. bore, with a body 20 ins. long, having 3-16 in. platinum tubes 3 ins. long extending from the body. The tube contains a roll of platinum gauze 4 ins. long, filling the bore of the tube and pushed into combustion tube until the anterior end is over the first burner, this gauze is followed by a roll 1½ ins. long, of silver foil inclosed in a piece of platinum foil, which just fills the bore of the tube, and this is then followed by the boat; the tube being closed by a cone-shaped ground joint which is reinforced by bands of nickel.

The combustion furnace is an ordinary 10-burner Bunsen furnace.

The absorbing train is made up of two U-tubes giving a total length in tubes of 44 ins.; these are followed by a Geissler potash bulb containing KOH solution (sp. gr. 1.30), (after a bulb has absorbed about ½ gram CO_2 a fresh one is used), and a 4-in. $CaCl_2$ tube containing solid KOH. The bulb and tube are weighed, and these are followed by an 8-in. $CaCl_2$ tube filled with solid KOH to prevent any CO_2 from the outside air entering the apparatus. The first U tube of the train is filled for the first 5 ins. of its length with granulated silver. This silver is removed from time to time as it becomes dark colored on the surface, ignited and replaced in tube. The silver is followed by 17 ins. of $CaCl_2$. In the next U tube there are 11 ins. of $CaCl_2$, then 11 ins. of anhydrous $CuSO_4$, followed by a plug of glass wool. The $CuSO_4$ is renewed after every 5 combustions. When the U tubes are first filled a combustion is made in the ordinary manner, but no weighings made, the object being to saturate any caustic lime which might be in the $CaCl_2$ used. The entire train is supported on a special support which permits of adjustment in a vertical or horizontal direction.

Determination of Manganese in Steel.

Weigh 200 milligrams of steel into a 2 oz. flask, add 20cc. of 1.20 HNO_3. When dissolved, boil gently for 5 minutes, remove and pour the solution into a 100cc. graduated cylinder. Wash out flask 3 times with H_2O, finally dilute to 100cc. mark. Pour the contents into a 4 oz. precipitating jar and mix by pouring into cylinder or jar at least three times, draw off 25cc. with a pipette into the flask in which the solution was made, add 6cc. HNO_3 (1.20 sp. gr.) from a burette, place on a hot plate together with a standard in which the manganese is exactly known and which has been treated exactly like the steel, and when almost boiling add ½ gram lead peroxide, measured approximately on a small glass spatula, and boil for 3 minutes. Remove, place in a cooling bath, and allow the PbO_2 to settle, which usually requires 15 minutes. Decant the solution into a comparison tube and compare with the standard properly diluted as for color carbon determination.

Determination of Manganese in Pig Iron.

Dissolve as for steel, place a small funnel in the cylinder and filter. Wash the residue thoroughly, being careful not to allow the washings to exceed 100cc., treat the filtrate as in case of steel.

Determination of Nickel in Steel.

Dissolve 1 gram of steel in 25cc. HNO_3 (sp. gr. 1.20) and boil in a 100cc. flask, until solution is complete. Wash contents of flask into a ½ gallon flask containing 700cc. hot water, add 100cc. sodium acetate solution and bring to a boil for one minute. Remove from plate and let settle for 3 minutes, filter through a 38½cm. pleated filter into a litre beaker, allow the precipitate to run dry. To the filtrate, which should be perfectly clear and almost colorless, add 3 drops phenolphthalein, then NH_4OH until pink, place on hot plate and pass a current of H_2S gas through the solution for 10 minutes, remove from the plate and add 12cc. acetic acid (50%), stir and allow the precipitate to coagulate on warm plate for 10 minutes, filter through

a 12½ cm. filter and wash with H_2S water made slightly acid with acetic acid. Roast in a platinum crucible, carefully at a low red heat (usually at the front of muffle) until the paper has just burned off. Take out crucible and break up the precipitate with platinum rod to powder, then place in the muffle and ignite for 15 minutes at a bright red heat, cool and weigh. To the crucible add 3cc. (1.20 HCl), cover with a watch glass and warm gently on a plate until the precipitate has dissolved. Wash into a 150cc. beaker with H_2O, add NH_4OH until the solution smells strongly of NH_4OH and filter from the SiO_2 and $Fe_2(OH)_6$. Redissolve precipitate in 3cc. HCl and repeat the precipitation with NH_4OH, wash with hot H_2O, ignite in same crucible and weigh. The difference in the weight gives the NiO. A correction of 5% in the quantity of nickel present is made to provide for the nickel remaining in the basic acetate precipitate.

The sodium acetate solution is made by dissolving 3,000 grams of sodium acetate in 12,000cc. water.

A NEW CONDUIT ELECTRIC RAILWAY SYSTEM.

The strength of public feeling against electric trolley railways has decreased considerably within the last few years, as people have come to understand better the small danger from over-

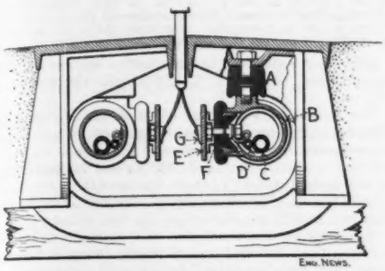


Fig. 1.—The "K A. K." Conduit Electric Ry System.

head wires under ordinary conditions, and consequently we hear of fewer schemes for underground conduit constructions than we did a few years ago. There remain, however, enough objections, on account of unsightly poles and wires, accidents from broken wires, electrolysis, etc., to furnish an incentive to inventors to improve upon the trolley line by placing the wires underground. From time to time Engineering News has illustrated and described the most successful of these inventions, and this record is continued here with the illustration of a new conduit system which seems to possess several good features, and which is stated to have worked successfully upon a short experimental line. This system is known as the "K. A. K. surface and

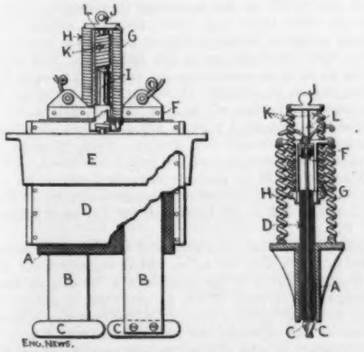


Fig. 2.—Trolley for "K. A. K." Conduit Electric Ry.

subsurface electric system," and is controlled by the firm of Krotz, Allen & Kelly, of Springfield, O. The inventors are Mr. A. S. Krotz, of Springfield, O., and Mr. W. P. Allen, of Chicago, Ill.

Fig. 1 shows the conduit and electrical construction for ordinary street railways. The cast-iron yokes rest on ties between the rails, the top of the conduit being flush with the top of the rails. Between the yokes the conduit consists of a metal casing. From the top of the yoke the insulated hanger A carries the gas pipe B. Inside this gas pipe is the insulated feed wire C. Auxiliary feed wires D, in independent lengths of from 500 ft. to 700 ft., are connected to the main feed wire C, each length of auxiliary wire carrying the current for a corresponding length of track and being connected to the main wire by fuses and switches inclosed in water tight boxes. It will be seen that any length of track can be cut out by simply switching off the current from the corresponding length of auxiliary feed wire. From the auxiliary feed wire the current passes to the contact rail E by means of the bolts F, placed every 24 ft., and from the contact rails it is conveyed to the motor by means of the shoes G.

The foregoing explains the essential features of the system as far as the conduit construction goes. It will be seen that both positive and negative wires are very fully insulated; the feed wires being insulated and inclosed in a water-tight pipe, and the pipe itself being also insulated from the metal work of the conduit. Especial stress is laid upon the efficiency of this insulation by the inventors.

Fig. 2 is a detail of the trolley used. B B shows two springs made of flat steel or spring brass. On their lower ends are attached cast-iron shoes C C for making contact with the conductor rails, as shown in Fig. 1. These shoes can be replaced at a trifling expense. The springs B B, one positive and the other negative, are curved in opposite directions at the bottom, and pass through and are supported in insulating material A which is protected and supported by the steel covering D, which in turn is fitted loosely in the base E, which is fastened permanently to the trucks. Springs B and B, which are fastened together at the top by the insulating fiber strip F, pass loosely through the insulation of casing D, and are held down by the springs G and H, which are attached to the post and cross bar I, J and K. The casing D is in turn held down by heavier springs K attached to the standard L and the base E. Binding posts are provided at the upper ends of springs B B, to which the wires leading to the motors are attached. To raise the trolley from the slot, a lever on the platforms attached in a proper manner to the cross bar J is provided, by which a single pull first raises the springs B B, drawing the shoes away from the rail, and together at the bottom of the casing D, as shown, and raising the casing D, and themselves from the slot. When raised the shoes are clear of the top of the conduit and the car can be moved by any other method of applying the power. This allows of the car being interchanged with lines having overhead trolleys, i. e., the conduit system can be used in the main city streets and the overhead trolley system in the suburbs.

This conduit trolley and the electrical construction in the conduit constitute the principal features of the system being described. To apply it to elevated railways and steam railway lines, the conduits are modified to suit the conditions, but the trolley and feeder construction are exactly the same in principle. Where cars are run in trains each car may have its motor and trolley or there may be a single motor car or locomotive to which the current is carried from the trolleys on each car, current thus being taken from a long length of contact rail. This last feature allows a section of track to be "cut out," say, at the crossing of another track, without interfering with the supply of power to the motor car, as long as the section of track "cut out" is not longer than the train.

Mr. W. P. Allen informs us that an experimental line several hundred feet long has been built at Springfield, O., and subjected to every test possible with so short a line to determine the efficiency of the system. This line has shown that the insulation is nearly perfect, and that snow and rain cause very little trouble. The company now stands ready to take contracts for equipping street railway lines with its system and will guarantee its practical operation.

PROSPECTS FOR RAILWAY CONSTRUCTION AND FOR MANUFACTURING IN CHINA.

We reprint the following review of industrial affairs in China from a report by Minister Charles Denby to the Department of State, dated at Peking, April 6, and just made public. It doubtless gives a more reliable view of the prospects for railway construction in China than the numerous reports of great contracts, concessions, etc., secured by foreigners there which have been published during the past few months in the newspapers:

The failure of foreign war and internal disturbances to adversely influence trade is noticeable. Notwithstanding the cession of Formosa and the closing of the Niuchwang custom house during several months, the trade of China with both western and Asiatic countries increased and expanded.

The trade with the United States, while less than for 1894, was greater than for any other in the preceding eight years. The exports to the United States in 1895 amounted to $12,168,271; the imports from the United States to $4,028,707, of which more than $2,373,000 were for kerosene oil. It is noticeable that in 1895 the import of Russian oil exceeded that of American oil in quantity and value for the first time in the history of the trade. This is accounted for by the large stocks of American oil imported in 1894 and held over.

The close of the war with Japan was looked forward to by foreigners as the date from which China was to depart from her traditional policy as to internal improvement and development. It was anticipated that this government would enter upon railroad construction, mining, and naval and military systems of great magnitude. While the views of the most enthusiastic have not been realized and China has shown a cautious conservatism, there has been no want of progress. The railroad from Tientsin to the vicinity of Peking has been authorized and is now being rapidly constructed. Great extensions of the line from Tientsin northward into Manchuria have been determined on, and will doubtless soon be undertaken.

As to the general problem of railroad construction, the Chinese Government stands committed to the policy of using Chinese money only. An imperial decree has authorized the formation of native companies for the construction of lines in the south. It is not believed, however, that this policy will avail for lines of any great extent, and it may be predicted that China will resort, eventually, to the aid of foreign syndicates.

The railroad development of China has attracted the attention of American financiers and builders of rolling stock and equipment. Many agents of American firms are now in this country awaiting the adoption of some definite plan by the Imperial Government. At least two combinations of American capitalists, represented here by agents, are prepared to build and equip from beginning to end any railroad system which China may desire.

In the matter of naval and military reorganization, China showed after the war little desire to take immediate steps. Confronted by a debt of 200,000,000 taels* to Japan, and without resources to meet it, the government decided not to pledge its credit for ships and guns which were not immediately needed. The conservatism was a disappointment to many agents of foreign manufactures, among whom were several American firms. The success of Europeans in this line of trade in the past has been due to long representation here and great patience. The high standard of excellence recently attained by Americans iif the production of ships, armor, and guns will doubtless enable them, by the adoption of a similar policy, to secure, in time, a share of this business.

The provision in the treaty of peace between China and Japan authorizing the subjects of Japan to engage in manufacturing in the open ports of China, a privilege which inured to the citizens of all treaty powers, seemed to open a wide and profitable field of investment to foreign capital. When the commercial treaty between the above powers came up for discussion, however, the value of the said privilege was considerably restricted by the unexpected assertion by China of a right to levy discriminating taxes on goods manufactured by Japanese at the ports, and also on such goods when shipped inland. This subject was referred to in my dispatch of Jan. 21 last, and the disagreement of the two powers thereon has not yet been settled. The unrestricted right of foreigners to manufacture in China is so fraught with momentous consequences to foreign manufacturing interests that the failure of Japan to secure immunity from taxation for the product of her mills in China would excite little sympathy in manufacturing communities abroad. It would seem, therefore, that dangers still confront foreign manufacturing establishments in this country which no foreign government would find to its interest to remove and that Americans about to embark in manufacturing enterprises here might be advised to take notice of them.

Intimately connected with the subject of manufacturing is the question of exchange. The customs statistical secretary says, in the first paragraph of his report:

Cheap labor and raw material are abundant, and with the continuance of the advantage which the East enjoys by the fall in the gold price of silver, there is every prospect of China becoming a most important manufacturing country, which will lead to a keen and formidable competition in textiles between east and west.

It is safe to say that it will be many years before native manufactured articles will drive foreign goods out of the market. The silver question cuts both ways. The mer-

*The average value of the Haikwan tael in 1895, according to the United States Treasury valuations, was 79.1 cents.

chant in China buys for silver and sells in Europe and America for gold; thus he largely gains. On the other hand, he buys in foreign countries for gold and sells in China for silver. Prices for foreign goods are necessarily raised, but the volume of trade continues to increase. Universal bimetallism would be welcomed by many foreign merchants residing in China, though the sentiment is by no means universal. It is safe to say that scarcely any one favors "free silver" for his own country alone.

THE STRENGTH OF MONIER PLATES.*

The growing use of iron and cement combined in construction has led Mr. T. Grut, Member of the Danish Society of Engineers, to investigate, theoretically, the strength of the so-called Monier plates, where a thin sheet, or combination of rods, of iron is built into the cement. He remarks that the usual method of assuming the neutral axis to pass through the center of the plate, as though the whole was a homogeneous mass, is a superficial one, and proceeds on more rational lines, by taking into account the different coefficients of elasticity of the two materials. That of iron being well known, the investigations have a special interest through the selection of a coefficient for cement. Experiments in Europe, and several by the author are reviewed, and it is concluded that for cement mortar 1 to 3, and half a year old, the coefficients of elasticity for tension and compression are practically alike, and their value lies between 300,000 and 400,000 kg. per sq. cm. (4,266,000 and 5,688,000 lbs. per sq. in.); nearer, however, to the lower limit. It is also noted that these values are considerably higher for the mortar mentioned than for pure cement.

After an extended analytical investigation, the author recommends the following two rules: First, that the neutral axis in a Monier plate, where the iron is placed at a distance of one-sixth the thickness of the plate from its lower edge, be assumed to lie at a distance of three-quarters the thickness from the same edge. In this case the tensile resistance of the cement is not considered; a course which the author believes to be the most prudent. Second, that the iron should not be strained above 525 kg. per sq. cm. (7,465 lbs. per sq. in.). This, the author remarks, is really using a safety factor of four, as the ultimate strength of a Monier plate is at the limit of elasticity of the iron; for as soon as that limit is passed, the expansion of the iron becomes so rapid that the cement, whether it be above or below the plate, can not follow it, but breaks, and the Monier construction, as such, is destroyed.

THE INVESTIGATION OF THE COST OF ARMOR plate ordered at the last session of Congress is being carried on by Secretary Herbert. It is stated that the Bethlehem Iron Co. has offered to supply an itemized statement of the cost of armor plate at its works.

CONVICT LABOR FOR ROAD WORK is being utilized in California and the California Highway Bureau has had a rock crushing plant erected at the penitentiary at Folsom. The convicts quarry the stone and attend to the crusher, and the broken stone is supplied free to road contractors, a check being kept to ensure that the stone is used for the purpose intended.

BOOK REVIEWS.

BICYCLE REPAIRING.—A Manual Compiled from Articles in "The Iron Age." By S. D. V. Burr. New York: David Williams. 8vo.; cloth; pp. 106; illustrated. $1.

This book is designed to be a practical manual for the use of those engaged in bicycle repairs. The various mechanical operations involved in the repairs of the various parts of a bicycle are described in detail, and in such a manner as to be clear to the ordinary workman. While there are many emergencies in repair work which are not touched on by the book, on the other hand we believe hardly any mechanic engaged in this class of work can peruse the book without finding some wrinkle that will be of practical use to him. The book will be found very helpful also by those who reside where bicycle repair shops do not exist, and who are therefore compelled to repair their wheels themselves, if they would not trust them to the tender mercies of the country blacksmith.

The chief criticism we have to make on the book is that its usefulness would probably have been greater if more space had been given to the actual description of methods of repair and less to the description of cheap hand-made devices for doing various jobs. The bicycle repair business has now become important enough for workers in it to afford to buy good tools. In fact, they often cannot afford to spend their time patching up cheap home-made substitutes.

HOW TO BUY LIFE INSURANCE.—The essentials to be considered in selecting a company. Policy restrictions and privileges, digested and classified for ready comparison. Tables showing dividends earned by 32 life insurance companies during the past ten years. By J. H. Lewis, P. O. Box 827, Denver, Colo. Published by the author. Small, 12mo.; cloth; pp. 198. $2.

While this little treatise is upon a subject somewhat aside from those usually discussed in this column, we feel that we can do no better service to our readers than to call their attention to its merits. Of the advantages of life insurance to every man who has others depending upon him for support, it is not necessary to speak here. Every intelligent man recognizes them. But we venture to say that there is no business of such great magnitude which is so little understood by those who patronize it.

Of the people who purchase life insurance, it is safe to say that not one in one hundred attempts an intelligent comparison to determine which of the many companies is the best for him to invest in. Few people ever think of such a thing. They select the company with whose name they are most familiar or the one whose local agent has the best success in winning their ear. It is manifest that a selection made in this way may be a wise one and may be the height of foolishness.

That men of the highest intelligence should be so careless in making an investment of such importance is inexplicable; and, moreover, it is wholly needless. The laws of the various states have so regulated the business of life insurance and enforced such publicity in its operation that any one who chooses may know all there is to be known concerning the merits of the various companies and of the different plans of insurance.

It is a very common fallacy with respect to life insurance that "one company is as good as another," or, to carry it still further, that since the object of all insurance companies is to pay to the beneficiaries of patrons a certain sum at death, that all plans of insurance are equally meritorious. Both these ideas are utterly fallacious; and so we may remark, is another idea, that because the premium rates are practically the same in all the "old line" companies, therefore the cost of a given amount of insurance is the same in all.

In the little book before us, the author describes first, the different plans of insurance and emphasizes the fact that there are actually only two plans, the assessment and the level premium plan. He describes each plainly and fairly and leaves the reader in no doubt as to the merits and demerits of each. The main part of the book, however, is devoted to a comparison of the various "old line" companies. All the various kinds of policies issued are described in detail and tables compiled from the State Insurance department reports show the results of the operation of all the principal companies for ten years past.

We cannot too strongly urge any of our readers who may desire to take out life insurance, to ignore what agents may tell them and instead take a copy of this little work, study the subject of life insurance for themselves and choose for themselves the best plan of insurance and the best company for their needs. A very moderate expenditure of time and study by any intelligent man will enable him to do this, and he can hardly expend either time or mental energy in a more profitable manner.

HEATING AND VENTILATING BUILDINGS.—An elementary Treatise. By Rolla G. Carpenter, M. S., C. E. M. M. E., Professor of Experimental Engineering, Cornell University. John Wiley & Sons, New York, 1895. 8vo.; cloth; pp. 411. $3.00.

The object of this book is to present first a statement of the scientific principles which apply to the subject of heating and ventilation of buildings; second, a collection of tests which give data showing the relation of theoretical principles to practical construction; third, a description of practical methods which are in use; fourth, a description of the methods of designing various systems of heating and ventilating; fifth, a collection of tables useful in designing. The work is arranged in a scientific manner, and the rules of practice are based on scientific reasons modified by such co-efficients as have been obtained by actual tests or experience. The chapter headings give a fair idea of the arrangement and scope of the work, and they are as follows: Nature and Properties of Heat; Principles of Ventilation; Amount of Heat required for Warming; Heat given off from Radiating Surfaces; Pipe and Fittings used in Steam and Hot-Water Heating; Radiators and Heating Surfaces; Steam-Heating Boilers and Hot-Water Heaters; Settings and Appliances; Methods of Operating; Various Systems of Piping; Design of Steam and Hot-Water Systems; Heating with Exhaust Steam, Non-Gravity Return Systems; Heating with Hot Air; Forced Blast Systems of Heating and Ventilating; Heating with Electricity; Temperature Regulators; Specifications, Proposals and Business Suggestions, Appendix, containing References and Tables.

The work is an important addition to the literature of ventilating and heating, and will no doubt take rank with the best treatises on the subject. In future editions we believe it may be improved by considerable enlargement so as to include details and illustrations of recent practice in heating and ventilating modern office buildings, auditoriums, etc., and by a careful revision of the text which will eliminate some unnecessary matter (for example, the C. G. S. system of physical measurements, with its dynes, ergs, etc.) and will give greater precision of language to some of the statements of scientific principles. We have read somewhat carefully the introductory chapters and note below what appears to be defects that may be remedied in the next edition.

Concerning the British thermal unit and the mechanical equivalent of heat the author says, page 4, "In English-speaking countries the heat unit is that required to raise one pound of water from a temperature of 62° to 63°." It is in fact almost universally defined as the heat required to raise a pound of water one degree at its temperature of maximum density, or from 39° to 40°, although some early writers have given the temperature as 32° to 33°, and a few recent ones 62° and 63°. Peabody, Thermodynamics, p. 5, says:

A calorie is commonly defined as the heat required to raise one kilogram of water from freezing point to 1° C., and a British thermal unit that required to raise one pound from 32° to 33° F. In our work, for reasons that will appear in the discussion of the specific heat of water, we shall choose 62° F. as the standard temperature, and shall define a British thermal unit as the heat required to raise a pound of water from 62° to 63°. This statement is subject to the same indefiniteness as the thermal scale from which it is derived. The true value can be defined only after a logical thermal scale is developed.

For other references on this matter see Wood's Thermodynamics, 5th ed., p. 3, and Trans. Am. Soc. M. E., vol. xiii., p. 351.

The author says further, on p. 3, concerning Joule's figure, 772, for the mechanical equivalent of heat, "Later investigation has amply confirmed this result. This value reduced to a temperature of 62° F. and for this latitude is increased 6 ft.-lbs., so that at present the work equivalent of one heat unit is generally regarded as 778 ft.-lbs." The fact is that the corrections for temperature and latitude are by no means as great as 6 ft.-lbs., and the later investigations referred to, no doubt those of Rowland, show that Joule's original figures must have been considerably in error. The correction for latitude is only about 1 ft.-lb. or 0.15%, and the correction for temperature is uncertain, and runs in opposite directions, according to whether we take Regnault's or Rowland's figures on specific heat of water. The correction for the difference of temperature between 39° F. and 62° F., according to Regnault, is only about 0.06%. Wood's Thermodynamics, p. 25, says, concerning the corrections:

"If the mathematical equivalent of heat at 60° F. were 774.1, then at 39.1° F. or, say 40° F., it would be 774 (nearly), and reduced from the latitude of Manchester to that of New York, it becomes 774.8, nearly; and if the entire margin of error, 1-400, be positive and applicable to this number, the value would be 776.7, or, to the nearest integer, it would be 777." Prof. Wood says further, "It is apparent that the old value 772 is much too small, and 774.1, recommended by the committee of the British Association (1876) is not sufficiently large. According to Rowland's experiments (1880), the British thermal unit is about 784 ft.-lbs. per degree on the air thermometer, and nearly 779 on the mercurial thermometer." He then selects from these and other data the number 778, as being probably within 1-300 of the actual value for the mercurial thermometer at the latitude of New York.

On p. 43 it is stated that air expands 1 part in 460 for each degree of increase of temperature, while on p. 6 it is stated that when air is at a temperature of 32° F. its volume is reduced 1 part in 492 each time that the temperature is lowered one degree. Both of these statements lack precision, and the first is incorrect. A correct statement would be that air expands 1-492 of its volume at 32° for each increase of temperature of 1° F., and contracts 1-492 of its volume at 32° for each decrease of 1° F.

Another peculiar definition of Prof. Carpenter is that of the C. G. S. unit of force, the dyne, which he says is 1 gramme moved so as to acquire a velocity of one centimetre per second. What he probably means to say is that it is that force which, if applied constantly to a free mass of one gramme for one second, would give it an acceleration of one centimetre per second. He also says "the force of gravity in latitude of Paris is 32.2 ft." The measurement of a force in feet is, to say the least, unusual. The physical constants defined in the beginning a work of this kind should certainly be defined with more precision and clearness of language. Another sample of the author's style in his introduction is the following: "Heat has two qualities which correspond in a general way to intensity on the one hand and to quality on the other. The intensity of heat is termed temperature; this can be measured by a thermometer, but, except in scientific definitions no name has been applied to designate the unit quality of heat (the term entropy is now applied in scientific discussions to this property) and there is no method of measuring it directly, although it is of as much importance as temperature." A lack of scientific precision of statement and of clearness in expression characterizes much of this introductory chapter, and it might be improved by careful revision.

*Abstracted from "Ingenioeren," by O. J. Marstrand, M. Am. Soc. C. E.

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